

REGIONE LIGURIA

**Updating
SMART SPECIALISATION STRATEGY
2021-2027**

Regione Liguria

**Document drafted in collaboration with
Liguria Ricerche S.p.A.**

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1 INTRODUCTION

This document is an update of the Smart Specialisation Strategy (S3) for the programming period 2021-2027. As is well known, the main objective of S3 is to support investments focused on key priorities at national and regional level, identified through a bottom-up approach, which involves all stakeholders in the world of research and innovation in order to define the areas of specialisation of the local economy. As in Annex IV of Regulation (EU) 2021/1060 of the European Parliament and of the Council of 24 June 2021 containing the Common Provisions applicable to the funds of the 2021-2027 cohesion policy, S3 is the enabling condition linked to the Strategic Objective 1 (OS1) and in particular to the Specific Objectives 1 and 4., where:

The Enabling condition is "Good governance of national or regional Smart Specialisation Strategy"

The Strategic Objective 1 (OS1) is "A more competitive and smarter Europe through the promotion of innovative and smarter economic transformation and regional connectivity to ICT"

The Specific Objectives 1 and 4 are "Develop and strengthen research and innovation capacities and the introduction of advanced technologies" and "Develop skills for smart specialisation, industrial transition and entrepreneurship".

In particular, in order to fulfil the qualifying conditions and to use the resources of the EU funds correctly, before starting the new programming seven specific criteria have to be met and maintained throughout the whole 2021-2027 programming cycle:

1. An updated analysis of the challenges for the diffusion of innovation and digitalisation;
2. Competent regional or national institutions or bodies responsible for S3 management;
3. Monitoring and evaluation tools to measure the performance against the objectives of the strategy;
4. Functioning of cooperation between stakeholders ("entrepreneurial discovery process");
5. Necessary actions to improve national or regional research and innovation systems, where appropriate;
6. Where appropriate, actions to support the industrial transition;
7. Measures to enhance cooperation with partners outside the Member State in S3 supported priority areas.

In this regard, Regione Liguria has therefore proceeded primarily to draw up the *self-assessment* report requested by the European Commission, with the consequent fulfilment of enabling condition 1 "*Good governance of national or regional Smart Specialisation Strategy*".

Subsequently, considering also the self-assessment report, this document was also updated considering the changed reference context.

<p>Criterion 5 Necessary actions to improve national or regional research and innovation systems, where appropriate</p>	<p>The regional governance of the research and innovation system currently used in Regione Liguria, is based on the regional law n. 2/2007 and subsequent amendments. In article 3 and in art. 3 bis, as per the latest revision, indicates the set of subjects who contribute to the development of the regional system of research, innovation and higher education and it is established that the Region is the subject in charge of conducting a coordination role. The use of this model has led to a proficient level of coordination and integration between the various subjects of the system.</p>	<p>Par. 2.5 – Subjects of the research and innovation system</p>
<p>Criterion 6 Where appropriate, actions to support the industrial transition</p>	<p>The current regional S3 already identifies themes and transversal approaches as priorities such as, for example, Industry 4.0, Circular Economy, Bio economy, Blue Economy, Cybersecurity, etc. as drivers to favour the evolution of traditional and mature industries into emerging ones.</p> <p>Furthermore, Regione Liguria actively participates in the National Technological Clusters SPRING, Fabbrica Intelligente, Blue Italian Growth, Alisei and Smart Communities, for a constant alignment of the guidelines of the national and international context.</p> <p>Regione Liguria has launched actions aimed at managing the phenomena of industrial transition in the sectors expecting an economic-productive transformation, guided by innovation and by the new dynamics of environmental sustainability. The regional interventions aim, on the one hand, to enhance the development opportunities of the territory offered by innovation (digitalisation), on the other to intervene effectively to stem the possible negative effects on "traditional" sectors, deriving from automation processes and the need to retrain the workforce.</p>	<p>Par. 7.2 – Safety and quality of life in the territory</p>
<p>Criterion 7 Measures to enhance cooperation with partners outside the Member State in S3 supported priority areas</p>	<p>The extra regional target is reached through synergies initiated in concert with territorial cooperation projects in which the regional administration is involved. A key contribution also comes from the S3 Thematic Platforms for promoting transnational and interregional collaborations between regions and countries with similar or complementary S3 strategic areas.</p> <p>European/international accessibility represents a strongly characterising dimension of the S3 paradigm for the 2021-2027 programming period. For this purpose, Regione Liguria will further strengthen the synergy and complementarity of European macro strategies and programming within the regional S3.</p>	<p>Par. 8 –Regione Liguria 2021-2027 strategy</p>

In the light of the above, the document structure is the following:

- **Analysis of the ligurian context:** updating of the reference context with particular attention to the analysis of the scenario in terms of research, development and innovation, in order to provide updated reference contexts and collaboration opportunities also at an international level;
- **Regione Liguria programming 2014-2020:** analysis of the results of the interventions realised within the regional S3;
- **Entrepreneurial discovery process:** consultation activity carried out through a process aimed at including the business and research world and the new emerging activities in the area, similar to what was done during S3 definition, with the extension of the scope of consultation to civil society;
- **SWOT analysis:** which highlights the main strengths and weaknesses of the reference context;
- **Lessons learnt:** summary of the experiences developed in the 2014-2020 programming and of the related lessons and guidelines for the 2021-2027 programming;
- **Regione Liguria Smart Specialisation macro-sectors:** monitoring of areas of specialisation, with sub-sectors updating based on the context dynamism and on emerging priorities, identifying the best development potential on which to favour the convergence of public-private resources;
- **Regione Liguria 2021-2027 Strategy:** identification of the general objective and specific objectives for the implementation of S3;
- **Governance, monitoring and evaluation:** implementation of a new monitoring system at the regional level and definition of the roles and functions of the subjects who, in various ways, work for the S3 implementation.

It is important to stress that the S3 update had to consider the profound changes in the global macro-economic scenario caused by the COVID-19 pandemic. This occurrence in fact contributed to the start of the definition of new balances from a smarter perspective, placing even more highlights the priorities, in particular digitalisation and sustainability, which will shape the socio-cultural, economic and environmental challenges of the future.

2 ANALYSIS OF THE LIGURIAN CONTEXT

2.1 Structural elements

The **resident population** in Liguria on 1 January 2022 was 1,507,438 inhabitants (estimated figure), with a decrease of 5.2% compared to 2012. The twenty-year projections (2042) formulated by the National Institute of Statistics (Istat) indicate a further 7.8% decrease of residents in the region.

54.1% of the inhabitants live in the province of Genoa, followed by Savona (17.8%), La Spezia (14.3%) and Imperia (13.8%). As we know, the share of the **active population** is lower than in Italy and in the Northwest: residents aged between 15 and 64 in Liguria are only 60.3% of the total (provisional 2022 data), compared to 62.9% of the North West and 63.5% of Italy.

The oldest age group, the over 64s, represents 28.9% of the resident population in Liguria: in the Northwest it reaches 24.5% and in Italy 23.8% (provisional data).

In Liguria, the old age index¹ is historically much higher than the national and Northwest average and as of 1 January 2022, it was 267.4. From 2012 to 2022, the indicator has increased by 30.8 points: growth rates are faster in the areas of reference, which however have significantly lower levels (187.9 in Italy and 195.9 in the Northwest).

According to the National Institute of Statistics data for 2021, the region records a lower birth rate than the national average: 5.6 births per thousand inhabitants, compared to an Italian average of 6.8‰ and an average of 6.6‰ in the Northwest (provisional data).

The **total growth rate** of the population to 2021 in Liguria is negative and equal to -7.3‰ (provisional figure). The natural growth rate in Liguria is also negative (-9.4‰, provisional data) and decreasing compared to 2011 (-6.3%).

As for the **labour market** in 2021, Liguria presents an overall positive picture: the employment rate is 63.5%, higher than the national figure (58.2%), while the unemployment rate is 8.4%, compared to 9.5% in Italy. The activity rate, at 69.4% in Liguria, remains above the national average (64.5%).

77.6% of those employed in Liguria belong to the tertiary sector, particularly to commerce; this figure is well above the national average (69.3%).

As for the **productive structure**, in 2021 Liguria ranks 13th among Italian regions in terms of the number of active enterprises and 7th in terms of entrepreneurial density². There are 131,668 local units (latest data available for 2019) in the territory and they correspond to 14.2 per 100 inhabitants aged between 15 and 64, compared to a national average of 12.3 and the North West average of 13.7. In 2021, the incidence of the manufacturing sector in Liguria was 7.1% of total active enterprises, while in the Northwest it reached 10.0% and in Italy 9.1%. The tertiary sector in Liguria consists mainly in commerce (26.3% of total active enterprises compared to 23.3% in the Northwest), tourism (with hotels and restaurants for 11.0% of total enterprises, compared to 7.3% in the Northwest), real estate (5.7% of total enterprises) and transports (3.4%).

Significantly above the national figure is handicraft: in 2021, the handicraft rate³ in Liguria was 26.9%, compared to 21.2% in Italy. This characterisation of the production system also influences the size of the enterprises; that is why, today in Liguria there is a clear prevalence of small enterprises, especially micro enterprises.

¹ Percentage ratio between elderly people over 64 and young people up to 14 years of age

² Entrepreneurial density calculated as the ratio between the number of active enterprises and the active population. Source: Infocamere (Consortium company of the Italian Chambers of Commerce) 2021 and Istat (National Institute of Statistics) 2021 data processing.

³ The handicraft rate indicates the percentage ratio between registered handicraft businesses and total registered businesses.

According to 2020 Istat data, 96.2% of active Liguria companies are micro-enterprises, i.e., companies with fewer than 9 employees. The remaining number of enterprises is as it follows:

- 3.4% small enterprises (employee class 10-49);
- Only 0.4% companies with more than 50 employees.

The average number of employees in 2019 in Liguria is 3.6 per local unit, compared to 3.7 at national level and 4.1 in the Northwest. As for foreign trade, Liguria has a low export capacity: in 2020 (latest data available), with a value of 15.3%, it was the 13th in the national ranking. The index is significantly lower than both the national average (26.4%) and the Northwest (29.9%).

Compared to total exports, however, in 2021 Liguria achieved a share of 42.9% within sectors with dynamic world demand, a percentage higher than both Italy (32.0%) and the Northwest (35.3%).

As far as the competitiveness of Liguria and its recent positioning in the European scene, you can refer to the Regional Competitiveness Index (RCI), a regional competitiveness index published by the European Commission for the year 2019 (fourth edition). In 2019, Liguria ICR settled at 49, lower than the European Union average (60) but higher than the Italian one (42).

The index value allowed Liguria to rank on the 172nd position among the 268 European regions and on the 8th place among the Italian regions.

Liguria excels in terms of well-being; this excellent quality allowed the region to obtain almost the maximum score also as far as its infrastructures. The latter due mostly to the railway equipment that ranks first in Italy and fourth among the peer regions for its capillarity and efficiency.

As concerns firms' specialisation, values similar to the average for the European Union and the comparison group have clearly emerged. The excellent positioning of the gross benefit and employment recorded in high-potential sectors contrasted with a scarce presence of innovative SMEs in the area.

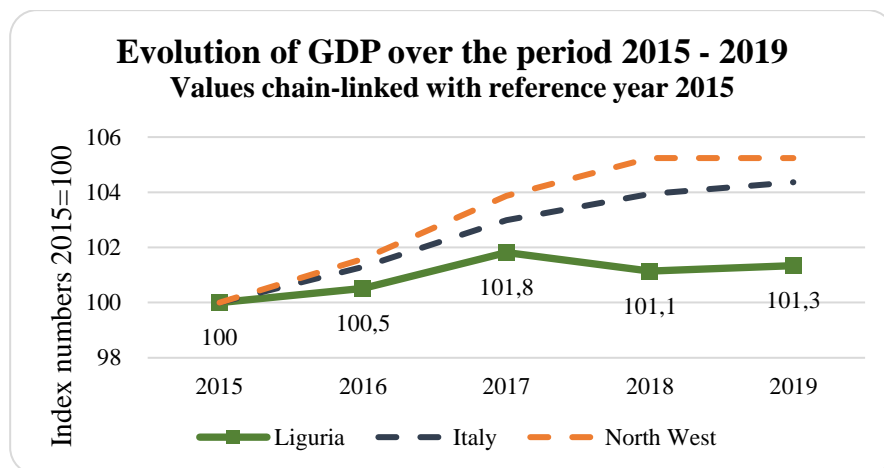
Values in line with the European average were recorded also in terms of extent of the internal market and innovation, thanks respectively to one of the highest per capita incomes at national and European level and to the leading role that Liguria plays for exports of medium-high technology products.

The remaining pillars (*institutions, technological readiness, higher education/lifelong learning and labour market efficiency*) have a value below the European average.

2.2 Socio-economic trend in the medium term

2.2.1 Macro-economic variables

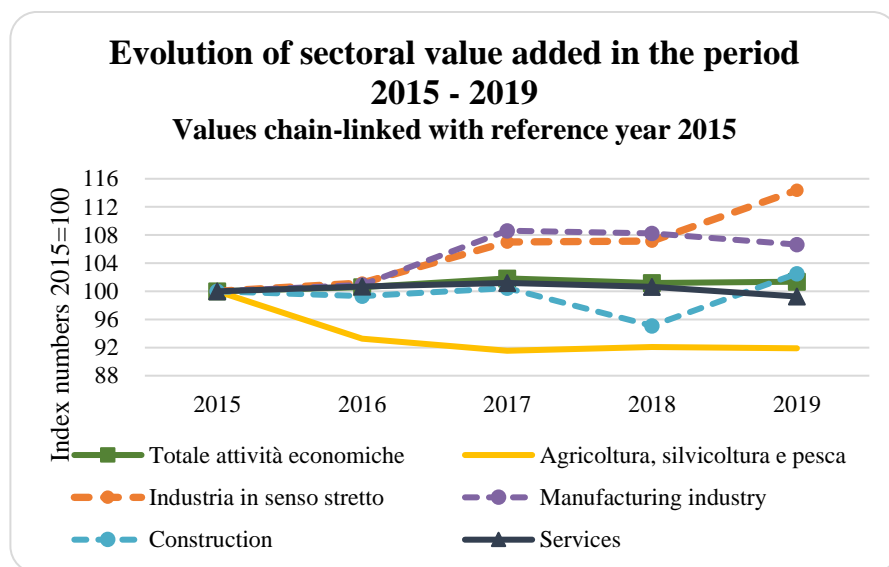
Regarding macroeconomic variables, the 2015-2019 analysis, excluding the pandemic year 2020 whose peculiar dynamics will be analysed below, shows how, in 2019, the regional GDP had started to increase again, albeit at a slower pace than in Italy and the Northwest. From the comparison with 2015, the increase recorded in Liguria was in fact equal to +1.3% compared to +5.2% in the Northwest and +4.4% in Italy. The regional per capita GDP in 2019 stood at a level of around 31,400 euros; higher than the national figure (28,900 euros), but still lower than the geographical area of origin (35,800 euros).



Source: Liguria Ricerche processing on Istat data

In the same period, the benefit also appeared to grow (+1.4%) thanks to the trend recorded in the industry sectors (+11.4%). Compared to the territorial contexts of reference, however, the growth appeared to be more contained: +5.3% in the Northwest and +4.4% in Italy.

From a sectoral point of view, industry in the strict sense and the manufacturing sector represent the most competitive part of Liguria production system, especially in the last three years. On the other side, however, agriculture, forestry and fishing recorded the most intense negative trend.

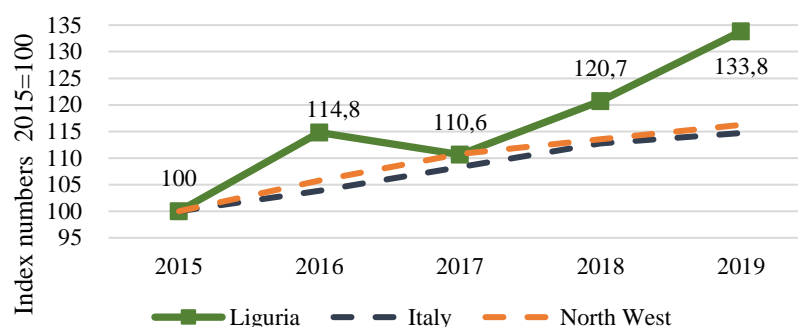


Source: Liguria Ricerche processing on Istat data

During the reporting period, household consumption also appeared to be recovering, increasing by 3.4%, compared with +4.2% in Italy and the Northwest.

Gross fixed investments were also growing, the only regional variable to present a more intense positive trend than that recorded in the two reference contexts (+33.8%, compared to +14.7% in Italy and +16.2% in Northwest).

Evolution of LFS in the period 2015 - 2019 Values chain-linked with reference year 2015



Source: Liguria Ricerche processing on Istat data

Year 2020 trend

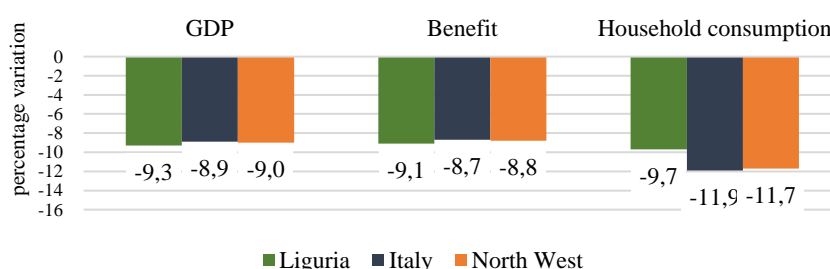
Year 2020 was not considered in the medium-term analysis as it was a particular year, characterised by the pandemic and therefore with anomalous values that cannot be compared with the previous years. However, to complete the picture, this box briefly reports the trend of macroeconomic variables in 2020, compared with the previous year.

In 2020, regional GDP decreased by 9.3% compared to -9.0% in the Northwest and -8.9% in Italy. The per capita GDP stood at a value of 28,600 euros, compared to 38,400 euros in 2019.

Also benefits dropped more than in the territorial contexts of reference (-9.1% compared to -8.8% in the Northwest and -8.7% in Italy). The most significant decrease was recorded in agriculture (-13.7%), followed by services (-9.3%) and construction (-5.3%).

Household final consumption costs decreased by 9.7%, compared to -11.7% in Italy and -11.9% in the Northwest. As per Gross Fixed Investments, however, figures updated to 2020 are not available.

Macro economic variables variations 2019-2020



Source: Liguria Ricerche processing on Istat data

Finally, an analysis on the region's foreign trade for the period 2015-2021. **Exports** show positive signs, a 15.3% increase, although lower than for the Northwest (+17.9%) and for Italy (+25.2%). **Imports** had a higher increase equal to 60.2% (compared to 28.3% in the Northwest and 25.8% in the country).

2.2.2 Labour Market

Currently, the available data on labour market trends, released by Istat following the revision of the Labour Force Survey, concern the period 2018-2021. In this timespan, the labour market shows signs of strain especially in 2018-2020, with a recovery trend in 2021. In the period, there is an overall decrease in the level of employment, although less than in Italy, and a simultaneous reduction in the unemployment rate. Overall, between 2018 and 2021, employed people in Liguria decreased (-1.2%), in line with the national average trend (-1.8%). Sector-wide, employment diminished in constructions (-8.8%), trade (-7.2%) and services (-1.7%); the increases in agriculture (+86.8%) and industry per se (+3.8%) are not enough to compensate this decline.

The unemployment rate, which in Liguria stood at 8.4% in 2021, decreased by 1.4 percentage points: the decrease is slightly more intense than the decrease recorded for Italy (-1.1 percentage points).

2.2.3 Productive fabric

As far as active companies are concerned, in the period 2015-2021 there was a decline (-0.4%) in contrast to what was observed for Italy (+0.4%). Particularly noteworthy is a contraction in the stock of agricultural enterprises (-6.0%), of industrial ones (-1.0%), with reference to manufacturing activities (-5.2%), of those operating in the trade (-6.0%) and in the transport and warehousing business (-7.8%). On the other hand, there is an increase in constructions (+0.7%) and services (+5.3%, excluding trade).

2.2.4 Export by technology level

To analyse the levels of technology incorporated in the various productions, and therefore in the goods exported and their evolution over time, the Eurostat/OECD classification was applied to foreign trade data, which groups the manufacturing sectors into four classes: high-tech industry, medium-high-tech industry, medium-low-tech industry, and low-tech industry. This is obviously an approximation, also linked to the availability of data for ATECO levels, which by their nature cannot fully grasp the intrinsic technological level. As seen in the table below, regional exports of manufactured products concern medium-high and medium-low technology. Compared to 2015, however, this second category recorded a sharp decrease in sales of goods abroad (with a compound annual growth rate of -7.4%), against growth rates achieved by the medium-high technology (+3.3% annual average).

High-tech industry, albeit recording less significant shares, experienced the greatest acceleration: the compound annual growth rate (CAGR) shows that the sales of more technological goods have marched, during the period examined, at decidedly higher rates, recording an average annual increase of 16.5%. Even if only slightly (+0.1% per year), exports of low-tech goods increased.

Regional exports of manufactured goods by technological intensity (million euro)

	2015	2016	2017	2018	2019	2020	2021 ¹	Compound annual growth rate
High-tech industry	236	247	280	388	669	592	294	16,5%
Medium and high technology industry	3.160	3.747	3.903	3.560	3.220	3.837	3.978	3,3%
Medium-low technology industry	2.020	2.012	2.345	2.138	1.678	1.270	1.992	-7,4%
Low technology industry *	781	753	874	795	829	785	851	0,1%

* Category C33 does not present regional level data for exports of goods ¹Provisional data. Source: Liguria Ricerche processing on Coeweb data

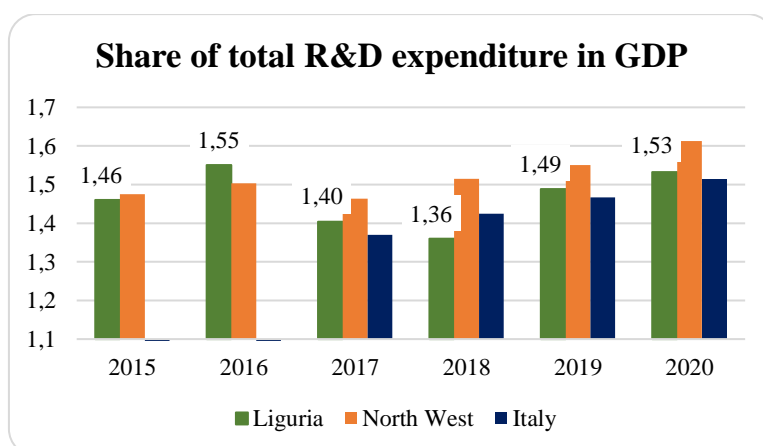
2.3 Research and innovation in the medium term

2.3.1 Research and Development

Research and development (R&D) are a strategic variable in the competitiveness of economic systems. Expenditures on research and development activities are divided into in-house expenses, for R&D activities conducted by companies with their own personnel and equipment, and extra-house, which includes all R&D expenditures commissioned outside the company (public or private). Information on in-house R&D activities represents the main component of the statistical indicators on R&D used in Europe to evaluate policies to support research and improve the innovative and competitive capacity of a country. In 2019 (latest data available) the total national expenditures in-house R&D, conducted by companies, public institutions, private non-profit institutions and universities, amounted approximately to 26.3 billion euros, with a percentage incidence on GDP equal to 1.47%.

The distance from the Europe 2020 target, which for Italy is equal to 1.53% of R&D expenditures in relation to GDP, is decreasing.

At regional level, 2020 Istat data show a total expenditure of 708 million euros in Liguria for R&D in-house (enterprises, public institutions, private non-profit institutions and universities), with an increase of 2.3% compared to 2015. The proportion of total regional R & D expenditures, in relation to GDP, is 1.53%. The figure has therefore increased compared to 2015, reaching the second highest value since 2010.

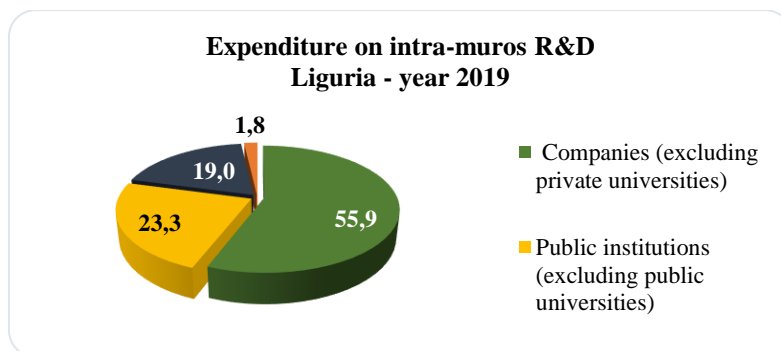


*NB: Istat does not provide 2015 and 2016 national data
Source: Liguria Ricerche processing on Istat data*

2020 figures show the predominant role played by enterprises (excluding private universities), which represent the main source of financing of in-house R&D expenditure (55.9% of total expenditure, compared to a national average of 61.8%) Although the share decreased by 1.4 percentage points compared to 2015.

It is important to highlight the strategic role assumed by the public sector: the participation of public institutions contributes to the financing of 23.3% of total expenditure, a much greater share of the Italian average (13.2%) and the fourth highest at national level. In this case, the percentage share increases slightly compared to 2015 (+1.7 percentage points).

The share of universities, both public and private, contributes instead to 19.0% of total regional expenditure (down 0.8 percentage points compared to 2015), while that of private non-profit institutions applies to 1.8% (+0.5 percentage points compared to 2015). For both sectors, in 2020 the regional share is lower in comparison to the national level, equal to 23.1% and 1.9% respectively.



The number of R&D employees in 2020 stands at a value of 5.6 employees per 1,000 inhabitants, showing growth compared to 2015. Despite the increase, the Liguria figure is lower than the national average (5.8 per thousand inhabitants) than the Northwest (6.9 per thousand inhabitants) and places the region in ninth place nationally.

A focus on the number of researchers shows that, in 2020, 41.2% of them work in companies, 24.4% in public institutions, 29.7% in universities and 4.7% in private non-profit institutions.

Regarding the share of companies that have carried out R&D activities in collaboration with external parties, the regional figure for 2019 stands at a percentage of 43.1%, down by 4.0%, 5 percentage points compared to 2015 and among the lowest values of the historical series of Liguria. However, the regional figure is higher than the national average (30.9%), the Northwest (29.0%) and sees Liguria in fifth place among the Italian regions.

Companies that have conducted R&D activities using research infrastructures and other R&D services from public or private entities, instead, in 2019, are equal to 38.4% of companies with in-house R&D activities. This is an increase of 5.4 percentage points compared to 2015 and is the best figure of the four North West regions and the third highest at national level.

This trend is associated with the previously observed increase of in-house expenditure, partly explaining the positive trend.

The university system is an important player in research and development and is part of many regional projects.

The collaboration between the Liguria University and the five Research and Innovation Clusters of the area, the University's membership of various National Technological Clusters and the collaboration with numerous local stakeholders, both public and private is of particular significance. This collaboration intends to both enhance research, technological innovation and training and consolidate synergies with the productive and social sector.

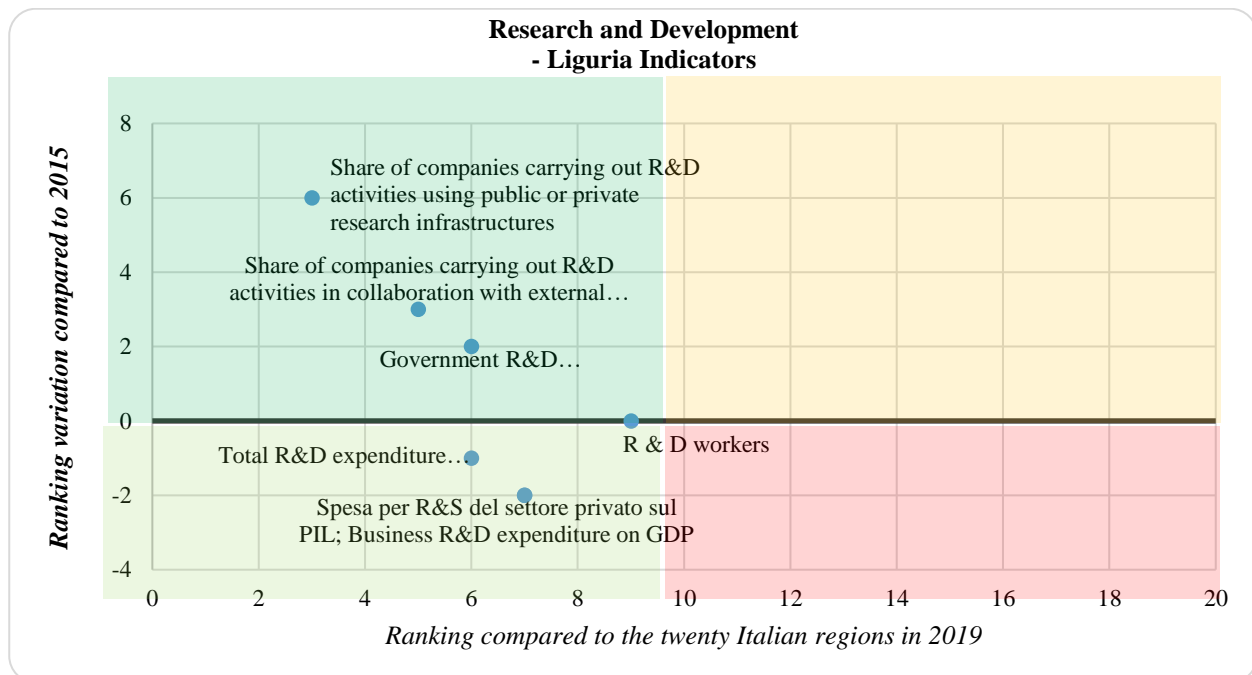
The engagement of both University and the 5 research and innovation clusters in the projects of the European Territorial Cooperation also represents a solid link between the various actors of the regional system in experimenting and applying on the territory what has been achieved by the R&D sector through concrete projects useful to face territorial challenges.

Finally, to complete the analysis on research and development, it is interesting an in-depth study on regional patent registration.

According to data provided by the Italian Trademark and Patent Office, in 2021 Liguria registered 426 patents, a marked increase compared to 380 in 2015, which corresponds to only 0.9% of the total registration applications nationwide.

By way of comparison, Lombardy, Lazio and Piedmont jointly cover almost 60% of the total Italian applications. Liguria records slightly higher, but still marginal, percentages if we consider the number of trademarks (1.4%) and designs (1.1%) filed in 2021. Overall Liguria shows good performances in the field of research and development as shown in the following table, the positioning of the regional indicators

always sees Liguria in the top part of the national ranking (within tenth position) and only three indicators show a change in negative positioning.

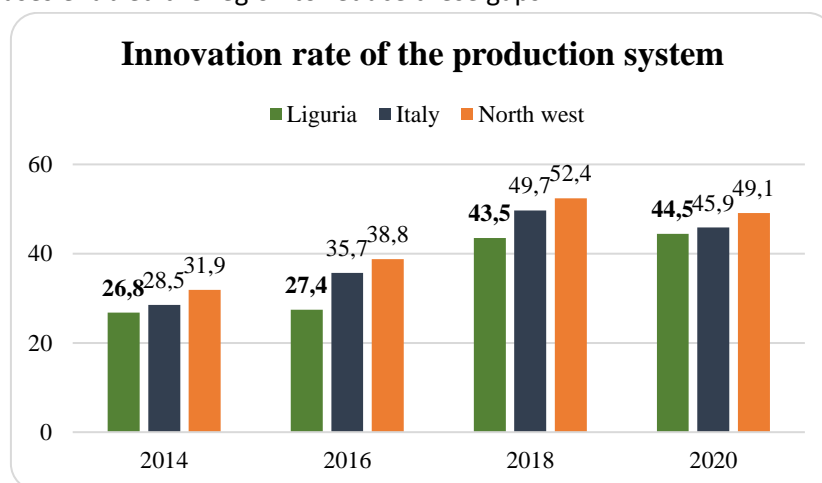


2.3.2 Innovation

In terms of innovation, the most recent Istat data refer to 2018. In 2018 Liguria recorded a number of companies with innovative activities (according to the 2018 Oslo Manual) equal to 1,590 and equivalent to 47.7% of total enterprises; this percentage was relatively low compared with the other regions of the peninsula and placed Liguria in 13th place at national level. In the same year, 11.0% of regional enterprises chose cooperation agreements for innovation.

In 2020, by contrast, 44.5% of regional enterprises have introduced product or process innovations; this figure, *also known as the rate of innovation of the production system*, has recorded a continuous growth in each of the biennial surveys from 2014 (year in which this value equalled to 26.8%) placing Liguria in tenth place nationally.

Although the regional value is still below the national average (45.9%) and the Northwest (49, 1%), progressive increases enabled the region to reduce these gaps.



From the annual report on the state of performance and on the impact of policies in support of **innovative start-ups** and SMEs⁴, it emerges that, in 2020, only 1.6% of Italian innovative start-ups were located in Liguria (187 start-ups out of 11.983), placing the region in 16th place among the twenties of the peninsula for relative incidence. Lombardy and Lazio are in the first places (with percentages of 27.1% and 11.7% respectively).

The intense diffusion of start-ups is partly due to the presence of certified incubators in the area i.e., companies that offer services supporting creation and development of innovative start-ups. Liguria has a single certified incubator, located in Chiavari.

Liguria's positioning improves slightly when analysing the number of innovative SMEs: in this case, the 36 SMEs present in the area in 2020 are equivalent to 2.0% of the national total and place the region in 13th place by relative incidence.

Analysing the demographics of companies in knowledge-intensive sectors, in 2020 Liguria has a birth **rate** of 7.4% compared to a national average of 8.5%; whereas if a three-year survival rate is analysed, Liguria records a percentage of 54.7% (compared to a national average of 54.1%).

Finally, the expenditure on innovation supported by regional companies, in 2018, amounted to around 3 billion euros; if calculated in relation to the number of employees of innovative companies, with a value of 36.1 thousand euros per employee, it places the region in first place nationally.

Therefore, the excellent performance of Liguria emerges in relation to expenditure on innovation per employee.

2.3.3 High-technology sectors

For the level of regional innovation assessment, it is interesting to analyse the presence of **active technological companies** in the area: in 2021, the share in Liguria was equal to 1.8% of total active companies. Compared to 2015, the number of technological companies active in the area decreased by 4.0%, due to the sharp decline recorded by companies in the manufacturing sector (-19.3%), a decrease which is not offset by the one in the sector of services (+17.3%). In manufacturing, the decrease affects all sectors compared to the increase recorded by all services sector and, with the greatest intensity, by scientific research and development (+33.0%).

Technological companies active in Liguria (2015-2021)

		2015	2021	Var. % 2015-2021
MANUFACTURING	Chemicals production	151	135	-10,6
	Computers and peripheral equipment	56	42	-25,0
	Telecommunications equipment	34	30	-11,8
	Electro medical equipment	31	27	-12,9
	Electrical equipment	215	169	-21,4
	Machinery and equipment	424	330	-22,2
	Motor vehicles, trailers and semi-trailers	49	41	-16,3
	Other means of transport	514	415	-19,3
	Total	1.474	1.189	-19,3
SERVICES	Mailing services	81	102	25,9
	Software production, informatics	873	1.000	14,5
	Scientific research and development	109	145	33,0
	Total	1.063	1.247	17,3
TOTAL		2.537	2.436	-4,0

Source: Unioncamere

⁴ Annual report to the Parliament 2021 about the state of implementation and the impact of policies to support innovative start-ups and SMEs - Ministry of Economic Development

Production specialisation in high-tech sectors⁵, in 2021, is equal to 3.1%, a lower percentage compared both to the national one (4.0%) and the regional (4.9%) average. The regional indicator recorded a slight increase compared to 2015 and ranks seventh among the Italian regions.

Knowledge workers, i.e., those employed with university education in scientific-technological professions, in 2021 represent a share of 18.8 for every 100 employed; this figure, although decreasing compared to the previous year, remains higher than the respective averages of the reference territorial contexts and is the fourth highest at national level.

Regional Innovation Scoreboard 2021

The Regional Innovation Scoreboard 2021⁶ (RIS), a study published by the European Commission in June of the same year, provides complete picture of the level of innovation in Liguria and Italy.

The new edition of the RIS highlights how, between 2014 and 2021, the innovative *performance* of regional systems improved for 225 regions out of the 240 examined.

The analysis of Liguria's positioning in the national and European context sees the region among moderate innovators, in the second lowest place in a scale that goes from "Innovation Leader" to "Emerging Innovators". The innovation performance of the region (calculated on the 2014 EU-based index) shows an increase of 28.2 percentage points compared to the RIS 2014 edition.

To achieve a better insight on the positioning of Liguria compared to the Italian and European average, it is necessary to analyse the values of the single indicators.

Liguria shows the **best performances** – above or in line with both Italian and European averages – in relation to the following indicators: International scientific publications; most cited publications; Public-private co-publications; Employment in knowledge-intensive activities; Sales of innovative products; Innovative SMEs with collaborative activities.

Positive performances but superior only to one of the two reference contexts are instead highlighted in relation to the following indicators: Tertiary education; lifelong learning; Above average digital skills; R&D expenditure in the public sector; Non-R&D innovation spending; SMEs that have introduced at least one product innovation; SMEs that have introduced at least one process innovation.

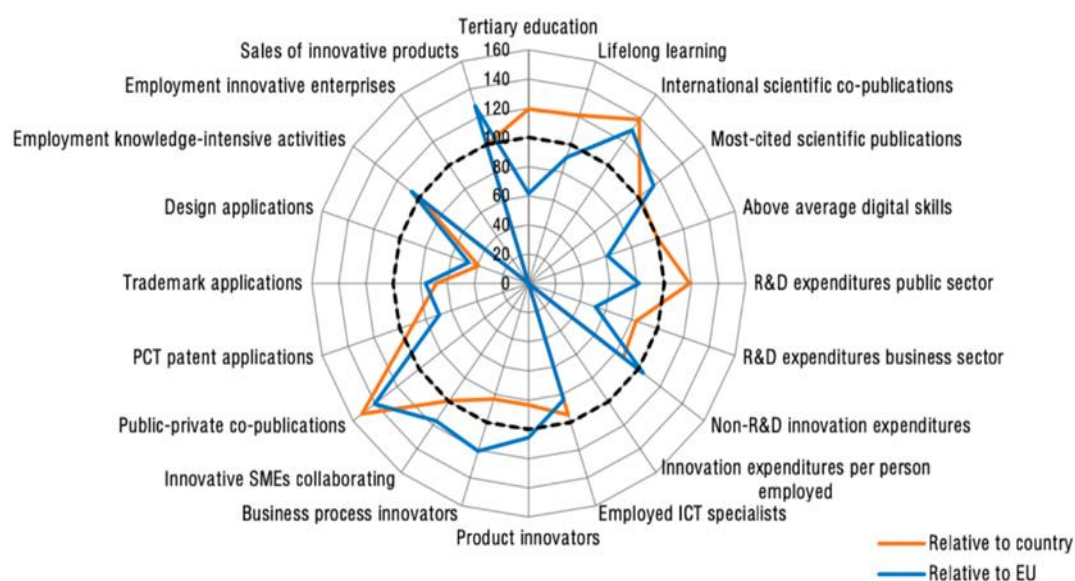
A performance lower than that of both reference contexts is due to R&D expenditure in the private sector, in specialists employed in the ITC sector and for patents, trademarks and registered projects.

Finally, note that no value is available for the indicators "Employment in innovative companies" and "Innovation expenditure per employee", which is why, in the radar chart; they both converge on the value zero.

⁵ The indicator is a percentage of total employment in high-tech manufacturing, knowledge-intensive and high-tech service sectors on the total employment.

⁶ The Regional Innovation Scoreboard (RIS) 2021 is a regional extension of the European Innovation Scoreboard (EIS) 2021. In the European Commission document, regional innovation is measured using a composite indicator – the Regional Innovation Index (RII) –, which summarizes the performance of 21 indicators made specifically available by the various national statistical institutes. Based on the RII value, European regions are classified as Innovation leaders, Strong innovators, Moderate innovators or Emerging innovators.

Regional Innovation Scoreboard 2021 – Performance Regione Liguria



Source: Regional Innovation Scoreboard 2021, European Commission.

2.3.4 Regional indicators on Smart Specialisation Strategy enterprises

The research on the regional productive fabric analysed the available data regarding Smart Specialisation Strategy enterprises. Specifically, an initial survey in 2017 involved a sample of over 23,000 companies representing all size classes. This survey examined the specific characteristics of the companies operating in the areas of the S3 strategies in comparison with those in other production areas.

The picture that emerges shows a context of better opportunities for smart specialisations enterprises in terms of greater competitive pressures and of greater opportunities for acquiring new knowledge generated by the presence of collaborative relationships and networks.

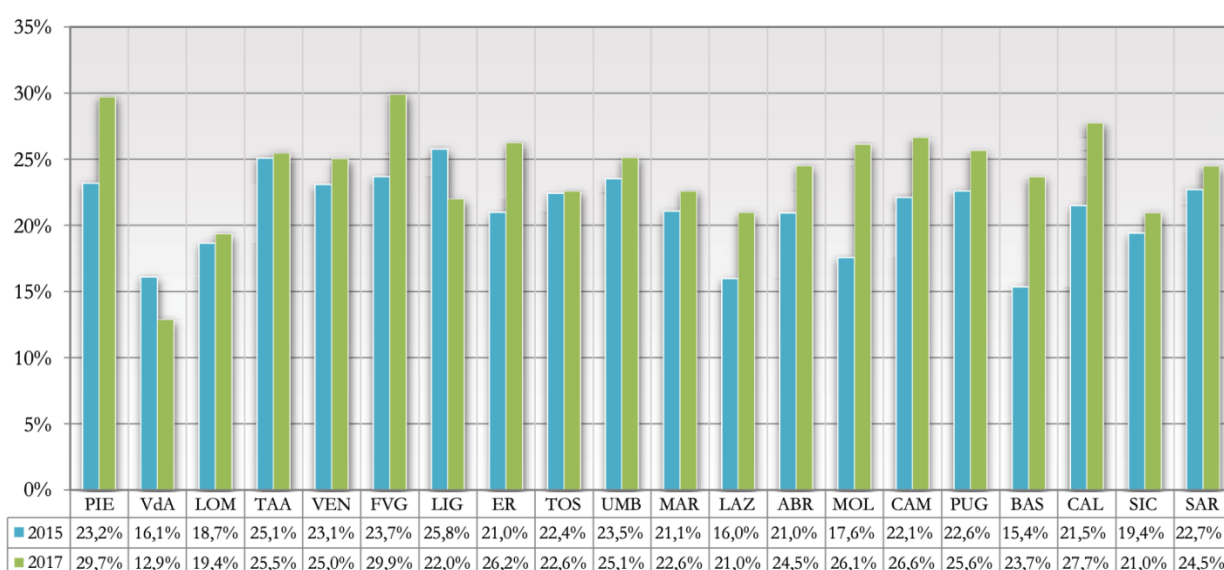
S3 firms have higher **labour productivity** (benefit per employee) and greater **openness to foreign markets**.

Furthermore, they show a greater **tendency to invest**, with quite an evident gap in case of intangible investments and training and have a more widespread **integration of digital technologies** and smart factory.

Overall, companies operating in smart specialisations field appear to be more oriented towards economy knowledge, as evidenced not only by the incidence of those that have conducted R&D activities, but also by the presence of managers and graduate employees and their belonging to collaborative *networks* with other companies and research centres.

Going down to regional detail, the analysis shows that in 2015 Liguria had the highest percentage of enterprises in the S3 area (25.8%). In 2017, however, the regional figure decreased, reaching 22.0%; in the period considered, Liguria, together with Valle d'Aosta, was the only region to have a decrease in its percentage.

Percentage of enterprises active in S3 by region of location

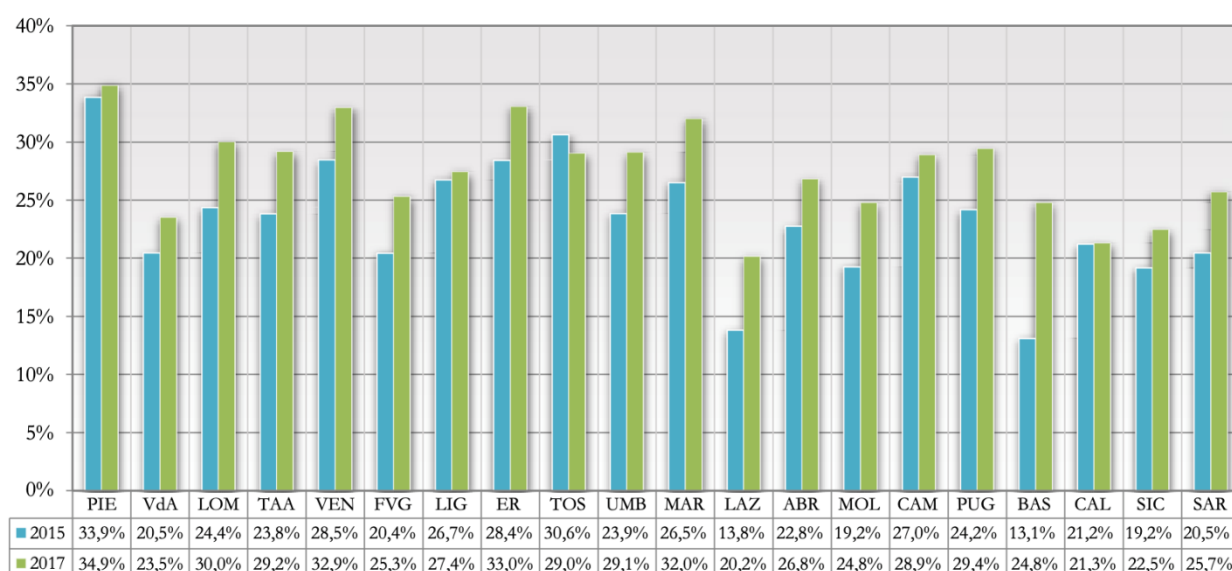


Sources: Territorial Cohesion Agency and MET (2019)

If we analyse the share of workers employed in S3 companies, the regional percentage records an increase in the considered period, going from a value of 26.7% in 2015 to one of 27.4% in 2017 and placing Liguria at about middle ranking among the regions of the peninsula.

The employment increase and the concurrent decrease in the number of active companies just surveyed suggests therefore an increase in the size of the companies in the area, or their merger or reorganization, with a consequent increase in the employed workforce.

Diffusion of S3 areas with regard to workers employed by region of location of enterprises



Source: Territorial Cohesion Agency e MET (2019)

In March 2022, Istat released a first edition of the S3 regional indicators for the 2021-2017 planning, processed as part of the Permanent Business Census⁷. These data provide analytical elements in terms of specialisation areas, functional to monitoring and periodic updating of Smart Specialisation strategies in

⁷ The aim of the census data observation relates to companies with at least three employees. Companies belonging to the agricultural sector (Ateco codes 01, 02, 03); public administration (Ateco 84) and activities of associative organizations (Ateco 94) are not considered. Ateco: classification of economic activities.

the current programming period. The data, depending on the indicator, refer to the year 2018 or to the three-year period 2016-2018.

Istat database divides indicators into areas of specialisation identified as strategic at national level in terms of Research and Innovation:

1. Aerospace;
2. Agribusiness;
3. Marine Economy;
4. Green Chemistry;
5. Design, Creativity and Made in Italy;
6. Energy and Environment;
7. Smart Factory;
8. Sustainable Mobility;
9. Healthcare;
10. Smart, safe and inclusive communities;
11. Technologies for Living Environments;
12. Technologies for Cultural Heritage.

The purpose of Regione Liguria, through the definition of its S3 strategy, is to identify the **areas of specialisation with the greatest potential for innovation and development on which to focus investments**.

The in-depth analysis of the regional system has thus led to the identification of three macro-areas of smart specialisation. They are listed below, together with the link between the priorities identified at national level and Liguria specialisation areas:

- **Marine Technologies**
 - the connection with the national priority is "Marine Economy";
- **Safety and quality of life in the territory**
 - the connection with the national priorities is "Green Chemistry", "Energy and the Environment", "Intelligent Factory", "Sustainable Mobility", "Intelligent, safe and inclusive communities", "Technologies for Living Environments" and "Technologies for the Cultural Heritage";
- **Healthcare and life sciences**
 - the connection with the national priority is "Healthcare";

The analysis, at a structural level, shows that in Liguria, in 2018, companies operating in the sectors of Health care (26%), Energy and Environment (22%) and Technologies for living environments (17%) occupied the first three positions by number of companies. The sectors with the highest **number of employees**, on the other hand, are Energy and the Environment (39%), Sustainable Mobility (34%) and Technologies for Living Environments (28%). The largest share of value added is produced by Energy and Environment (57%), Sustainable Mobility (45%) and Smart Factory (38%) categories.

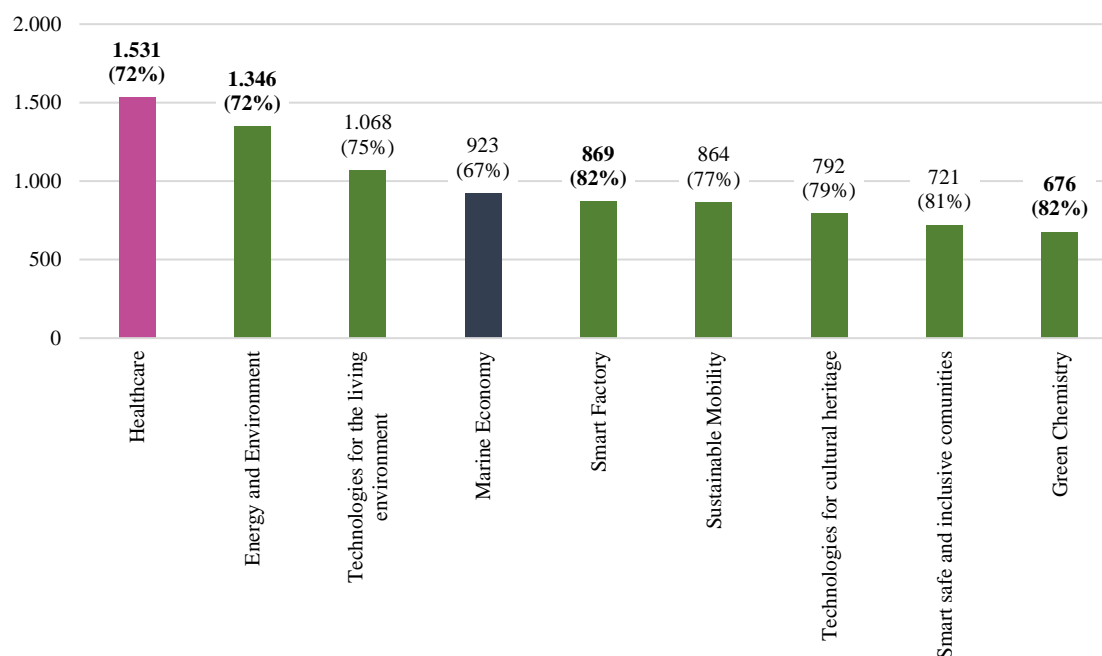
In the three-year period 2016-2018, the Energy and the Environment sector had the largest share of Investments in R&D, while the healthcare macro-area stood out for investments in Technologies and digitalisation.

In detail, the companies that presented the highest number of innovative projects are Health care (72%), Energy and Environment (72%) and Technologies for living environments (75%).

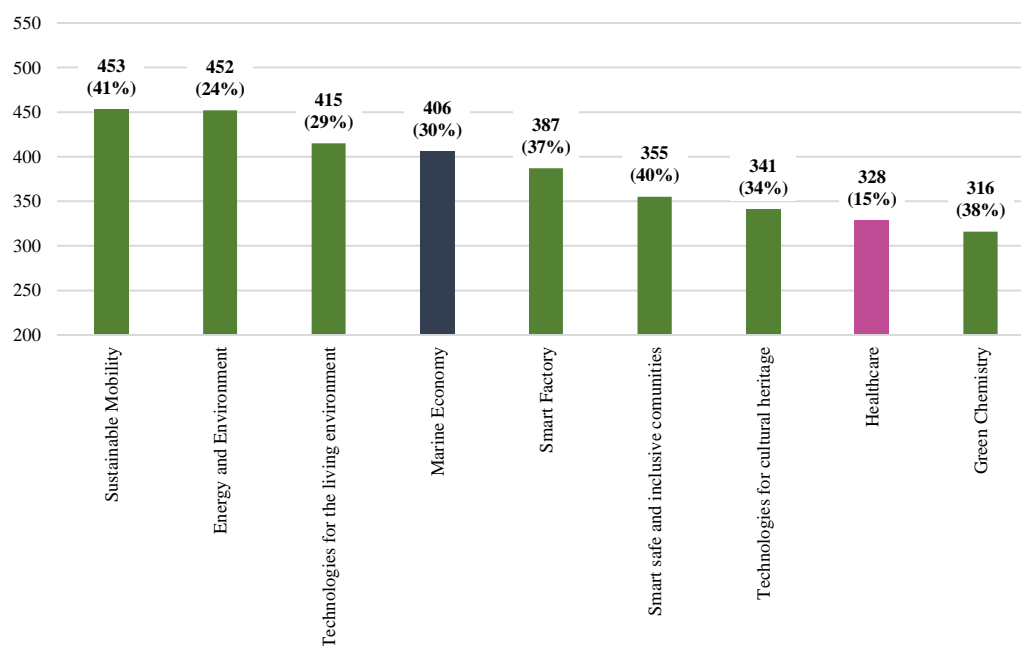
On the other hand, if we consider the number of companies that conducted R&D activities, Sustainable Mobility area ranks at first position (41%) followed by Technologies for living environments (29%), energy, and environment (24%).

The largest share of **R&D services** was acquired by Smart, Safe and Inclusive Communities companies' macro area.

Companies with innovation projects



Companies with internal R&D activities



NOTES: The percentage in the chart represents the percentage of companies with internal Innovation Projects/Research and Development Activities in the specific sector out of the total specialized companies in the region. The sum of the absolute values and the percentages is higher than the respective totals because a company can be classified in more than one area of specialisation.

Source: Istat – Permanent enterprises census

The number of companies that have activated **formal agreements with external bodies or companies** provides a further important indicator of the innovative development of companies. The analysis for the three-year period 2016-2018 shows how, as regards the definition of formal agreements with universities and research centres, most companies belong to the green chemistry sector, while as regards to formal agreements with the public Administration and with other companies, the largest share belongs to the sector of Technologies for cultural heritage.

Areas of specialisation	Companies with formal agreements with (%):		
	University, Research Centres	P.A.	other
Marine Economy	11,3	18,1	45,2
Green Chemistry	21,2	25,8	45,1
Energy and Environment	13,2	21,3	40,3
Smart Factory	17,9	24,8	47,8
Sustainable Mobility	17,3	26,5	52,0
Healthcare	10,1	23,9	25,1
Smart safe and inclusive communities	19,8	28,1	50,8
Technologies for the living environment	15,1	29,1	42,4
Technologies for cultural heritage	17,5	33,7	56,7
Total specialised enterprises in the region	6,0	14,8	20,8
Total enterprises in the region	2,8	8,3	13,5

NOTES::

- The percentage in the chart represents the percentage of enterprises out of the total of specialized regional enterprises belonging to the sector analysed.
- The percentages add up to more than their totals because a firm can be classified into more than one specialty area.

Source: Istat – Permanent enterprises census

Finally, an in-depth look at the companies that have **experimented with development processes**, again in relation to the three-year period 2016-2018, highlights a prevalence of companies belonging to the following sectors: Smart Factory (regarding modernization processes), Safe and Inclusive Smart Communities (diversification processes and transformation processes) and Cultural Heritage Technologies (transition processes).

2.4 THE NEW CHALLENGES OF DIGITALISATION

2.4.1 The digitalisation of public administration

To identify the shortcomings and needs of the regional public sector in terms of digitalisation, it is useful to start from the most recent data that has emerged regarding some specific reference indicators. The analysis and detail of the main indicators make it possible to evaluate the general trend of the innovation and digitalisation process over the last few years and which solutions have been effective or not.

The Public Administration can be a catalyst for the private sector digitalisation, taking advantage of its role as purchasing centre and requesting, in this perspective, the full digitalisation of the interaction procedures with its suppliers. Additionally, to promoting the development of digital infrastructures and services, it would make services to citizens and businesses more efficient and timely.

As far as Liguria Public Administration is concerned, in 2018 (latest data available), all the regional municipal administrations already had a **broadband connection**.

The percentage of population reached by ultra-broadband is equally high: Liguria is in fact in fourth and third place nationally for coverage of at least 30 Mbps (35.3%) and 100 Mbps (14.0%)⁸ respectively.

On the other hand, the number of **ultra-broadband subscriptions**, as a percentage of the resident population, has recorded a constant growth over the years, consolidating, in 2021, as the second highest value at national level (equal to 28.4% and up 25.0 percentage points compared to 2015).

Availability of public Wi-Fi in Liguria municipalities is equally quite high: between 2015 and 2018, (latest data available) public coverage increased, going from 66.4% to 74.1%, the most significant growth among the regions of the peninsula.

The 2018 value is the second highest at national level, exceeded only by Emilia-Romagna, confirming the excellent performance of Liguria in terms of availability of digital connections.

The use of **e-procurement** (22.2%) and the number of **Municipalities with fully interactive services**⁹ (32.5%), on the other hand, present a reduced share: despite the improvement in recent years, a structural element that influences these variables could be the very small average size of Liguria municipalities and their respective administrative systems.

The percentage of **people who have used the Internet to interact with the Public Administration** is definitely lower. Istat 2019 data according show that, in the last twelve months, only 29.6% of the population had used this service, a figure in line with the national average, but lower than the North West's (31.2 %) and which saw the region at the 11th place nationally.

Finally, the degree of **citizen participation via web in political and social activities** in 2021 is equals 24.3%, an increase value if compared to 2015 but still relatively low in comparison to the other regions of the peninsula.

⁸ Data refer to 2015, the latest year available

⁹ Municipalities with fully interactive services are those that process the requested services electronically from start to finish

Digital transformation index

In 2020, the annual report on Smart Cities in Italy, made by the company Forum PA, focused exclusively on the digital transformation process of Italian cities, analysing the performance of the 107 capital municipalities on eight indicators (all updated to 2020):

- 1) Online accessibility of public services
- 2) Availability of public utility apps
- 3) Adoption of digital platforms
- 4) Use of social media
- 5) Release of open data
- 6) Transparency
- 7) Implementation of public Wi-Fi networks and intelligent network technologies.

The digital transformation index, the arithmetic mean of the 8 sectoral indicators, makes it possible to build the **ranking** of digital cities in Italy.

The digital transformation process of Italian cities and their administrations did not stop in 2020, not even in the wake of the **pandemic**; furthermore, in many ways it received a boost that made it possible to overcome organizational and cultural resistance.

In terms of digitalisation of administrative activities and relationship with the citizens, the process appears to have started, even if the issue of territorial disparities and weak areas remains. The crucial problem today is the diffusion of a digital culture, both within administrations (in terms of skills and organization) and among citizens.

As for **implementation and interconnection of intelligent grids**, on the other hand, we are still at an initial stage in which there is much to do, both from the point of view of understanding the existing opportunities and from their effective use. It is indeed necessary to lead Italian urban centres beyond smart cities models and towards even more advanced ones such as responsive and adaptive cities, able of collecting and making the best use of information for services' management and definition of choices on urban structures involving every available actor.

The available resources for the recovery offer the great opportunity to adopt an innovation plan for Italian cities, which allows intercepting the technological transformation underway, precisely at the moment in which its potential is fully visible.

The survey shows that ten cities (Florence, Bologna, Milan, Roma Capital, Modena, Bergamo, Turin, Trento, Cagliari and Venice) have a "very advanced" level of digitalisation, followed by 15 other cities with an "advanced" level, including Genoa. La Spezia is among the 23 cities with a "fair" level of digitalisation, followed by Imperia and Savona with a "starter level of digitalisation" (fifth level for 27 Italian cities). Finally, we find eight cities with critical delays, almost all in the South (Taranto, Avellino, Caserta, Carbonia, Nuoro, Enna, Chieti and, lastly, Agrigento)

IL RATING DELLA TRASFORMAZIONE DIGITALE									
RATING	LIVELLO DIGITALIZZAZIONE	CITTA'							
AAA	MOLTO AVANZATA (10)	Firenze	Bologna	Milano	Roma Capitale				
		Modena	Bergamo	Torino	Trento	Cagliari	Venezia		
AA	AVANZATA (15)	Parma	Reggio E.	Palermo	Pavia	Brescia	Genova	Lecce	Cremona
		Prato	Bari	Pisa	Verona	Vicenza	Bolzano	Forlì	
A	DISCRETA (23)	Rimini	Mantova	Livorno	Monza	Piacenza	Siena	Ravenna	Treviso
		Udine	Perugia	La Spezia	Napoli	Ferrara	Novara	Pordenone	Padova
		Trieste	Lodi	Arezzo	Pesaro	Ancona	Verbania	Lecco	
BBB	INTERMEDIA (24)	Catania	Terni	Asti	Cuneo	Pescara	Frosinone	Matera	Vercelli
		Aosta	Reggio C.	Alessandria	Sondrio	Massa	Pistoia	Gorizia	Latina
		Viterbo	Grosseto	Sassari	Belluno	Como	Rovigo	Crotone	Campobasso
BB	AVVIATA (27)	Oristano	Siracusa	Macerata	Biella	Ragusa	Andria	Ascoli P.	Imperia
		Lucca	Varese	Trapani	Brindisi	L'Aquila	Potenza	Cosenza	Caltanissetta
		Messina	Salerno	Fermo	Foggia	Savona	Teramo	Rieti	Benevento
			Vibo						
		Isernia	Valentia	Catanzaro					
C	CON RITARDI CRITICI (8)	Taranto	Avellino	Caserta	Carbonia	Nuoro	Enna	Chieti	Agrigento

Source: ICity Rank 2020

A new document published in 2021, which however does not resume the same level of analysis as in 2020, updates the traditional "ICityRank" index built starting from 2017.

This tool makes it possible to determine the positioning of each city compared to the others through the comparison of eight sector indices.

In this new analysis, the Liguria capital often does not appear in the ranking of the top ten positions reported in the document and for this reason it is impossible to comment on the data.

The two areas "social PA" and "openness" are an exception, for which Genoa ranks ninth and eighth respectively. In the ranking of the overall index, the Liguria capital is in 15th place with a score of 779.

2.4.2 The Digitalisation of citizens

The analysis continues with an in-depth look at the level of digitalisation of Liguria citizens.

According to Istat data, in 2021 the percentage of households that have Internet access was 83.1%, a value slightly higher than the national average (81.5%) and the Northwest (82.8%) and which sees Liguria in sixth place among Italian regions (up by seven positions compared to 2015).

Among the population connected to the network, the data on Internet use in the last 3 months recorded a significant growth between 2015 and 2021 (+18.4 percentage points). The regional figure, with respect to the total population over 6 years of age, is thus equal to 77.4% in 2021 and sees Liguria in fourth position among the Italian regions.

A growing and almost similar trend in percentage points can be seen in the share of subjects who have used the Internet in the last 12 months, with the 2021 figure (79.7 %) being higher than the average for both reference contexts.

A focus on Internet use habits among the Liguria population highlights an improvement in the degree of Internet use among the population, but regional values often remain lower than the national average.

Among people over 14 who have used the Internet in the last three months, the mobile phone/smartphone represents the principal tool used (89.9% compared to 91.8% recorded nationwide), followed by the desktop computer (46.4%), laptop (26.5%) and tablet (25.6%).

As for overall digital skills, in Liguria 3.9% of the population declares that they have no digital skills, compared to 3.4% recorded in Italy and 2.8% in the North West; the regional percentage is the fifth worst at national level, getting closer to the values of the regions of the South rather than those of the North. On the other hand, 38.9% of the Liguria population declares that they have low digital skills, compared to 37.1% in the Northwest and 41.6% in Italy.

However, over half of the population (57.2%) has a medium-high knowledge of information technology: specifically, 28.9% has a basic level, while the remaining 28.3% declares a high knowledge of the matter. If for the first category the regional percentage is the second highest at national level, immediately after Trentino-Alto Adige, for the second class, the regional figure is lower than both the national average (29.1%) and the Northwest (32.0%).

In Liguria, the percentage of individuals with average computer skills therefore represents a good starting point; however, the next step is to consolidate and strengthen these skills to align with the values of the regions where the population with "high" digital skills is always over 30%.

2.4.3 Digitalisation at enterprise level

Digital transition constitutes a profound change in companies the value chain, from product design to production process methods, from company organization and management to logistics and relations with the market and customers.

The transformation generated by the pervasive and integrated use of digital technologies constitutes a radical change of technological and cultural paradigms, so much so that it has led to the use of the expressions "fourth industrial revolution" and "Industry 4.0"¹⁰.

Digital transition consists in a technological mix of automation, digitalisation, connection and programming and identifies, as key factors, a series of enabling technologies (Digital Enablers):

- the analysis of copious amounts of data (Big data)
- the use of information on open systems (Cloud)
- cyber-physical systems
- collaborative and interconnected robots (advanced manufacturing)
- 3d printers (additive manufacturing)
- electronic communication between machines and products (Internet of things)
- the human-machine interface
- augmented reality, rapid prototyping and experimental simulations
- nanotechnologies and smart materials
- artificial intelligence
- quantum computers
- block chain technologies
- Electronic integration of data along the various production phases of the company (horizontal integration) or with customers/suppliers on the state of the distribution chain (vertical integration).

¹⁰ The use of the term "Industry 4.0" dates to an initiative of the German government in 2011 (High-Tech Strategy 2020), Or countries have also implemented initiatives in the same area: Usine du Futur in France, Smart Factories in the Netherlands, and High Value Manufacturing Catapult in the United Kingdom. In Italy, a first reference (Fabbrica Intelligente) dates to 2012 in the development plan of National Technology Clusters, while a more direct one occurred in the "National Industry Plan 4.0 2017-2020

The concept of "digital maturity" refers to the company's ability to combine these technologies in an integrated and interconnected perspective. Digital transition, in fact, does not just imply the purchase of machinery and software to adopt new technologies, but rather represents an organic reorganization of the company, which presupposes an increase in internal skills and an adaptation of the organizational and management logic. An approach that considers new technologies, entrepreneurial culture, human capital skills and business process management to be interconnected.

The competitive advantages deriving from this new paradigm are numerous:

- Productivity gains due to processes optimization and mistakes reduction
- Greater production flexibility with respect to trends in demand
- More efficiency in the use of resources
- Possibility of exploiting data and information to interact with customers
- New commercial channels via the Internet (e-commerce), making foreign markets more accessible OR (digital export)¹¹.

Liguria fits into an already weak national context: the presence of a fabric with a prevalence of micro and very small enterprises, largely characterized by a "traditional" managerial culture, a low capital base and the well-known difficulties in accessing to credit, all these issues could hamper the digital transition process.

An analysis about the role played by information and communication technologies (ICT) within the digitalisation phenomenon was conducted, based on the most recent data released by Istat, to assess the changes that occurred between 2015 and 2021 within companies with at least 10 employees.

Its results show a growing percentage of employees who use computers connected to the Internet at least once a week: the regional figure goes from a value of 40.5% in 2015 to 53.3% in 2021, placing the Liguria in fifth place in the ranking of Italian regions.

Considering the role played by information and communication technologies (ICT) within the digitalisation phenomenon, an analysis based on the most recent data released by Istat was conducted to evaluate the changes that occurred between 2015 and 2021 within companies with at least 10 employees.

The results show a growing percentage of employees who use computers connected to the Internet at least once a week: the regional figure goes from a value of 40.5% in 2015 to 53.3% in 2021, placing the Liguria in fifth place in the ranking of Italian regions.

During the period under review, there was also an increase in online sales via web and/or EDI¹²-type systems, with the regional figure going from 8.1% in 2015 to 13.9% in 2021, but which is lower than both the national (18.4%) and regional (16.8%) average.

Compared to Italy and Northwest data, the regional companies recorded a higher percentage incidence in Internet connection maximum download speed (relatively to both 30 Mb/s and 100 Mb/s).

However, there are issues that are more critical for companies that have a website/home page and employees with portable devices and mobile Internet connections or personal computers. This happens

¹¹ *The good governance of the National Smart Specialisation Strategy 2021-2027-10 December 2020*

¹² *The good governance of the National Smart Specialisation Strategy 2021-2027-10 December 2020*

also for those companies that purchase cloud-computing services (equal to 52.0%, compared to an Italian average of 60.5% and to a value of the Northwest equal to 64.8%).

ICT in companies with at least 10 employees (*percentage*) – Liguria, Italy and North West, year 2021

Main indicators	Liguria	Italy	Northwest
Fixed broadband (DSL and other fixed broadband)	80,3	97,7	96,8
<i>Contracted maximum Internet connection download speed of at least 30 Mb/s (%)</i>	86,4	80,2	82,5
<i>contracted maximum Internet connection download speed of at least 100 Mb/s</i>	43,5	39,9	42,2
Companies with a website/home page or at least one page online	59,3	78,4	79,1
Companies providing employees portable devices and mobile internet connection for business purposes	59,4	64,3	69,9
Employees who use computers connected to internet at least once a week (% of total employees)	53,3	54,0	57,0
on-line sales via web and/or EDI systems	13,9	18,4	16,8
Companies purchasing <i>cloud computing services</i>	52,0	60,5	64,8

Source: Istat

The previous data and analyses show how digitalisation is especially important for small and medium-sized enterprises (SMEs) that must operate in an increasingly competitive market characterized by continuous changes. The opportunities offered by technology require various changes within the company itself with consequent financial investments in support of corporate reorganization of processes and/or procedures and for the insertion or training of professionals with digital skills that not all companies can support.

Finally, as recalled by the European Commission and the main national planning documents, businesses digitalisation requires, together with ambitious investments, a systemic approach and the involvement of all stakeholders to "raise the level of digitalisation of Italian SMEs and boost to the country's digital economy".

2.5 The subjects of the research and innovation system

Regional law n. 2/2007 and subsequent amendments lists the subjects of the research and innovation system of Liguria. In article 3 and in art. 3 bis, indicates the set of subjects that contribute to the development of the regional system of research, innovation and higher education and establishes that the Region is the entity in charge as coordinator.

Art. 3- Regional law n. 2/2007

THE SUBJECTS OF THE REGIONAL RESEARCH SYSTEM

The following subjects contribute, particularly, to the development of the regional system of research, higher education:

- a) The University of Genoa, through its structures and divisions in decentralized in Liguria provinces
- b) The National Research Council (C.N.R.), through its regional activity;
- c) The Agency for New Technologies, Energy and the Environment (ENEA), through its regional activity
- d) The Italian Institute of Technology (I.I.T.);
- e) The Liguria section of the National Institute of Nuclear Physics (I.N.F.N.);
- f) The Centre for Naval Technology Studies S.p.A. (CETENA);
- g) (Omitted)
- h) The Regional Institute for Floriculture of Sanremo;
- i) The horticultural agricultural district of Ponente Ligure,
- j) The Italian Welding Institute.
- k) (Omitted)
- l) the Integrated Intelligent Systems Technological District;
- l bis) the Liguria District of Marine Technologies;
- m) The Higher Institute of Information and Communication Technologies (I.S.I.C.T.);
- n) The IRCCS AOU San Martino IST National Institute for Cancer Research;
- o) The National Institute of Geophysics and Volcanology (I.N.G.V.);
- o bis) "Niccolò Paganini" Conservatory of Music in Genoa;
- o ter) Ligustica Academy of Fine Arts;
- o quater) International Environmental Monitoring Centre Foundation (CIMA);
- p) science and technology parks and business incubators, consortia, consortium companies and companies operating in the research field, with particular reference to the Research and Innovation Clusters referred to in article 3 bis,
- q) public and private subjects whose purpose is the implementation of programmes for higher education, for humanistic, scientific and technological research, for innovation and technological transfer to the production system operating in sectors of primary importance, among such as health, industry, tourism, agriculture, the environment, energy, logistics and transport;
- r) Public and private entities whose purpose is to finance humanistic, scientific and technological research, innovation and technological transfer to the production system.

Article 3a.

(Research and Innovation Clusters)

Regione Liguria promotes the Research and Innovation Clusters, as groupings of independent companies formed by start-ups of innovative companies, small, medium and large companies, as well as research organizations active in a given sector and intended to stimulate innovative activity, encouraging intensive interaction, shared use of facilities and exchange of knowledge and experience.

Among the subjects listed there are public and private research institutes and bodies, universities, innovation Clusters and technological districts, higher education institutions, realities of the entrepreneurial fabric that operate in the world of humanistic, scientific and technological research.

From the defined regulatory framework, it emerges that Liguria, as a whole, appears to be a particularly active region in identifying precise territorial vocations on which to focus investments. This has progressively contributed to concentrate the initiatives, as well as strengthen the regional position at a national level, leading to a significant and articulated presence on the territory of research structures that express various excellences in sectors of international importance (engineering: robotics and automation, telecommunications, life sciences, materials technologies).

Regarding the main subjects of the research system:

UniGe hosts 22 departments within 5 schools, 13 inter-university research centres and 1 Centre of Excellence. Its educational offer includes 132-Degree and Master's Courses, 28 PhD courses, 44 Graduate Schools and 27 first level and second-level master's degree programmes.

Under FP6 (sixth framework programme) UniGe has 92 projects, 115 contracts under FP7 (seventh framework programme), 94 contracts under Horizon 2020 and, to date, 3 contracts under Horizon Europe. Since 2014, UniGe also has 26 projects under other EU research programmes. As far as international Cooperation programmes are concerned, since 2000 UniGe has had 433 projects and is currently involved in 1 projects. Moreover, in terms of Territorial Cooperation, Unige is participating in 48 projects all on Interreg Programmes.

The National Research Council (CNR) mission is to conduct research activities in its Institutes, promoting innovation and competitiveness of the national industrial system, promoting the internationalization of the national research system, providing technologies and solutions to the emerging public and private needs, to advise government and other public authorities, and to contribute to the qualification of human resources. CNR conducts research activities within the regional S3 areas; for instance, it is now promoting the transition from Smart City to "Smart and Inclusive Cities". The key competencies for this role are in the presence of several local scientific structures that substantially contribute to the development of digital transformation in urban management (Department of Engineering, ICT and Technologies for Energy and Transport) with a focus on modelling/analytical aspects and advanced sensors. Furthermore, CNR Liguria has distinctive competences in promoting innovation in urban inclusion field and, in particular, of educational innovation (Dept. humanities and social sciences and Cultural Heritage).

IIT is a publicly funded Foundation, established at the end of 2003. Its aim is to encourage innovation and competitiveness of the Italian production system. IIT develops a basic and applied research programme with the aim of transferring research results to companies for commercial exploitation.

Its activities include scientific capacity development, construction and maintenance of state-of-the-art research laboratories, development of practices of excellence and positive competition, training and higher education at postgraduate level, creation of programmes to attract talent, and the wide spread of scientific knowledge and results. IIT operates mainly in four research domains (RD): robotics, nanomaterials, technologies for life sciences and computational sciences, with a distinctive multidisciplinary approach to the pursuit of excellence. Fourteen years after the opening of its headquarters in Genoa, IIT has entered its second decade with a solid critical mass of infrastructure, people and skills.

Alongside the subjects identified by the regional law, within the regional system are added the functions performed by the Regional Observatory on the research, innovation and higher education system and by the Steering Committee, both established by the Regional Law 2/2007:

- **The Regional Observatory** on the research, innovation and higher education system's task is acquiring and keeping updated information, documentation and statistical data on regional research, innovation and higher education activities.
- **The Steering Committee** is the advisory body of the Regional Council that provides support in programming and planning stages in the field of research, innovation and higher education. The Steering Committee is currently composed of representatives of the subjects who contribute to form the regional research and innovation system and its task is expressing opinions on programmes and initiatives to support higher education, research and innovation and development of the manufacturing sector.

Regione Liguria Research and Innovation Clusters

The Innovation Clusters, set up in 2011 following the publication of a regional call for tender, are an instrument whose aim is to work as specialized intermediaries for research and innovation. Their aim is achieved favouring and supporting both the connection between the scientific system and the entrepreneurial system and collaboration between companies, to increase the tendency to innovation of the production system. They are therefore committed, as a priority, to providing constant technological support and to developing the territory as a centre of attraction for high-tech companies, making it competitive in the international context.

The new Research and Innovation Clusters, conceived as an intermediate governance tool in support of regional policies and at the service of the development of innovation, have the function of aggregating innovative research companies and start-ups.

These clusters, which, having gone beyond the territorial base, operate by thematic areas, aim to promote a transversal collaboration between companies and the research system, to favour the effects on the territory and on the aggregate companies and has the final objective of creating a "Liguria Innovation System".

The Research and Innovation Clusters process of systemising was fundamental to reach the set goal through services for technology transfer and joint planning activities to increase the development capabilities of the aggregated companies with a vision oriented to internationalisation.

In 2017, Regione Liguria completed a rationalisation process for the Clusters themselves, as reported in the Regional Government Decree no. 245 of 03/24/2017 "Acknowledgment of the conclusion of the rationalization process of the Research and Innovation Clusters".

This process involved the 8 Research and Innovation Clusters existing in the area and a large number of innovative companies and start-ups, with a view to rationalisation and efficiency of the entrepreneurial productive fabric and the public-private system of scientific and technological research.

The reorganization started by identifying the three macro-areas of the Smart Specialisation Strategy (Marine Technologies - Healthcare and Life Sciences - Safety and Quality of Life in the area) and led to the creation of 5 new subjects:

- Automation and Safety Centre (SOSIA);

- "Energy, Environment and Sustainable Development" Regional Research and Innovation Cluster (EASS), aggregating the previous "Energy-Environment" and "Sustainable Energy" Clusters;
- Logistics and Transport Centre (TRANSIT);
- Liguria Life Sciences Cluster (PLSV), aggregating the previous POLITECMED, SI4Life and TECNOBIONET Clusters;
- Liguria Cluster of Marine Technologies (DLTM).

Through the creation of an IT infrastructure ([Piattaforma Open Innovation](https://servizi.regione.liguria.it/page/welcome/openinn)¹³) of opportunities, exchanges and collaborations, today Liguria Clusters are an excellence at national and European level and provide real investment opportunities for regional entrepreneurs, also contributing to raising the competitiveness of the regional economic system. The use of the infrastructure guarantees to innovation operators a space for discussion, for the exchange of knowledge and collaborative planning, facilitating the creation of open innovation ecosystems. The infrastructure also aims at promoting dialogue between regional stakeholders and the recipients of policies to support research, innovation and competitiveness, to maintain a continuous dialogue with the local area.

The IT platform has promoted an increasingly collaborative environment between the world of research and companies and among companies themselves, also facilitating the identification of new realities and innovative projects to support and develop.

Regione Liguria has widened the platform to make it more and more "open". Currently available functionalities for the Innovation Clusters and for the regional stakeholders will be available to the whole community, multiplying the effectiveness of the actions for the benefit of the entire territorial system.

Also thanks to the support of Regione Liguria, the Research and Innovation Clusters have consolidated and become more attractive. In fact, the number of aggregate members has had a positive trend, reaching today more than 500 aggregates as shown in the table below.

Denomination	SME	LARGE COMPANIES	INSTITUTIONS
POLO DLTM	79	15	8
POLO EASS	59	19	7
PLSV	111	12	12
POLO SOSIA	78	10	2
POLO TRANSIT	55	11	2

Regione Liguria Technological Districts

Liguria District of Marine Technologies operates in the nautical sector and marine technologies and its main missions are :

- To promote and strengthen synergies between research, innovation and training policies
- To improve the regional territory's ability to attract investments and talent by creating the conditions for the creation of start-ups and research spin-offs
- To favour internationalization processes of the reference sectors
- To develop perspectives of long-term self-sustainability.

¹³ <https://servizi.regione.liguria.it/page/welcome/openinn>

The District, also thanks to the resources made available by Regione Liguria using PAR FSC funds, has created three Cooperatives Research Labs (Co.Re.Labs) that work as aggregators of existing skills in Naval Measurement, Design and Simulation, High Performance Computing and Environmental Monitoring and Research on Marine Ecosystems areas. The ultimate goal is to activate aggregation processes, through the pooling of people and knowledge, to accelerate the competitive growth of the territory.

Liguria Technological District on Integrated Intelligent Systems and Technologies represents an integrated system between large, small and medium-sized industries, the University of Genoa, CNR, public and financial institutions, whose purpose is the development of joint industrial research and technology transfer activities, to favour regional competitiveness in line with the Smart Specialization Strategy.

It operates on six thematic platforms: Complex Organizations, Info mobility, Security, Automation and Robotics, Health, Energy, as well as on enabling technologies and services. It has common laboratories for Companies/Research Institutions, in particular for Hardware and Software Technologies and Processes, Grid Computing, Energy, Automation and Robotics, Intelligent Transport Systems and Logistics, Health, Safety.

National Technology Clusters

Liguria research and innovation network relating to strategic issues for the competitive development of the territory in recent years has been strengthened thanks also to an ever-increasing interaction with the National Technological Clusters. To date Regione Liguria is present directly or through the reference Research and Innovation Cluster in the following Clusters:

- Smart factory;
- Means and systems for land and sea mobility
- Life Sciences
- Technologies for Smart Communities
- Blue Italian Growth;
- Spring;
- Aerospace

In Regione Liguria strategy, National Technological Clusters play a fundamental role in increasing the level of territorial competitiveness as drivers of the sustainable economic growth of the territories and of the entire national economic system.

3 REGIONE LIGURIA 2014-2020 PROGRAMME

3.1 Introduction

The Smart Specialisation Strategy (S3), foreseen for the first time by EU regulations in the 2014-2020 programming period, has allowed the Region to direct and concentrate investments in research and innovation, enhancing the vocations and strengths of the regional system. The general objective of the document is "Strengthening research, technological development and innovation activities by exploiting both current and nascent strengths of the regional system, guaranteeing coordination and concentration of initiatives and the various sources of funding" in the seven-year period 2014-2020". In order to serve this objective, the actions taken have the aim to build an even more dynamic and competitive region, able of generating employment growth and promoting the evolution of the production system.

As foreseen also during the drafting of the document, it was necessary a synergy of actions based on different funds that maximized S3 results and strengthened the areas of specialisation. In this regard, the application of S3 has taken place through the combination of ERDF, ESF, PAR-FSC, and national (MISE *now MIMIT "Ministry of Enterprises and Made in Italy"*) and regional resources.

Following the COVID 19 pandemic, the programming had to consider the consequent and immediate impact on the socio-economic fabric, providing actions to support production realities for emerging needs. It was necessary to take specific measures, for example, but not limited to, strengthen the process of digitalisation of MPMI, which have contributed to strengthening the implementation of S3.

It is also worth pointing out that a strong contribution to the application of S3 came through the increase of territorial cooperation projects.

International cooperation is indeed a fundamental tool for Regione Liguria to encourage the exchange of new knowledge, to strengthen the competitive capacity of the productive fabric and to develop networking at a European and international level. In this context, the 2021-2027 Strategy has among its objectives that of strengthening synergies with territorial cooperation projects and, in general, with directly managed European projects.

Overall, the objectives achieved in the seven-year period 2014-2020 are the following:

- Support to the innovative capacity of a significant number of enterprises, increasing their competitiveness at regional and national level;
- Support to a significant number of micro, small, medium and large enterprises in carrying out complex projects of research and development activities;
- Strong increase in collaborations between business and research with the implementation of joint projects that have allowed for the development of technology transfer processes;
- Support for the development and consolidation of the Innovation Clusters and Technological Districts of the territory;
- Improvement of the digitalisation level of Liguria micro, small and medium-sized enterprises, promoting innovative models of work organization, also to guarantee the continuity of the company activity through smart working methods (*working from home*) as a result of the COVID-19 emergency;

- Support for the creation of new innovative entrepreneurship;
- Raising the skills of human capital, also for small and medium-sized enterprises;
- Support to the development of the regional R&I network.

Details of the main actions of the 2014-2020 period and an abstract of the results of the qualitative analysis carried out by the Regione Liguria in February 2022 for some measures (ERDF and ESF) which contributed to the implementation of S3 will follow. The ultimate objective of the analysis was to verify the effectiveness of the interventions and their impact on the territory and beneficiaries.

3.2 Actions

Main regional actions on Research, Innovation, Digitalisation	Year	Purposes/Objectives	Resources/Results
POR FESR 2014-2020 T.O. 1 Research and Innovation - Action 1.2.4 - Research and Development			
Complex research and development projects	April- September 2016	Support industrial research and experimental development in areas of specialisation, particularly the creation of new products, processes or services, through the development of enabling technologies to strengthen the competitiveness of the production system in areas of smart specialisation.	Budget: EUR 10 million. 26 financed projects, 41 beneficiary companies, 66 new researchers included in the financed companies. Declared investments: over 20 million euros.
Interventions localised in Savona area of industrial crisis	March - June 2019	Support implementation of complex industrial research and experimental development projects on a few important thematic areas and application of technological solutions functional to application of regional S3 strategies by micro, small, medium and large enterprises individually or in associations and Consortia in Savona crisis areas.	Budget: €3.5 million. 6 financed projects. Declared investments: over €5 million.
Support to the realisation of complex projects of research and development activities for companies aggregated to the Research and Innovation Clusters	November 2017 - April 2020	Support industrial research and experimental development activity for companies aggregated to R&I Clusters in specialisation area to: -encourage collaboration between companies and research system for the development of projects that respond to the needs of innovation and competitiveness in Liguria territory; - encourage the generation and sharing of new knowledge; - favour local and business impact on the territory and on the companies aggregated to Research and Innovation Clusters.	Call 2017: Budget: 10 million euros 14 funded projects, 67 beneficiary companies, 34 new researchers included in the financed companies. Declared investments: over 21 million euros. Call 2020: Budget: 18 million euros 23 funded projects, 108 beneficiary companies. Declared investments: 33 million euros.

Innovation Agreements	2018-2021	Projects concerning industrial research and experimental development activities aimed at creating new products, processes or services or at significantly improving existing ones through the development of key enabling technologies (KETs) within the areas of intervention related to the second Pillar of the Framework Program of Research and Innovation "Horizon Europe".	Co-financing of 10 projects by Regione Liguria from axis 1 of the ERDF OP: over 3 million euro. Total project value: EUR 64 million.
Support for animation, tutoring and support for companies participating in innovation clusters	2020	Stimulate innovation demand from companies, through technological animation activities and ad hoc actions to identify their needs in terms of research and innovation, Stimulate and accompany Clusters aggregated companies in participating in national and international research and development projects and initiatives, Promote the participation of new companies and/or research organizations in the Cluster and activate new services for adhering companies.	Budget: 500,000 euro. 5 funded projects. Declared investments: over 1 million euro
POR FESR 2014-2020 T.O. 1 Research and Innovation - Action 1.1.3 - Innovation			
Supporting innovation economic enhancement through experimentation and adoption of innovative solutions	April - September 2016 February 2017	Encourage investment projects in product and service innovation, process and organization, concerning the areas identified by the regional strategy of Smart Specialisation Strategy, in order to strengthen the production system competitiveness. Recipients: micro, small, medium and large enterprises in single or associated form (cooperative or consortium form) operating in the areas identified by S3.	Budget: EUR 20 million. 171 financed projects. Declared investments: EUR 46 million

POR FESR 2014-2020 T.O. 1 Research and Innovation - Action 1.1.3 and 1.2.4 - Strategic projects			
Large Companies projects	2015-2020	Development projects consisting in the implementation of industrial innovation research projects aimed in particular at new products development, production processes improvement or new technologies development in the strategic areas identified by the Smart Specialisation Strategy.	Budget: EUR 20 million. 2 financed projects Declared investments: 31.7 million euro.
POR FESR 2014-2020 T.O. 1 Research and Innovation - Action 1.5.1			
Support for research infrastructures considered critical/crucial for regional systems	2020	Enhancement and development of the research and innovation system by: <ul style="list-style-type: none"> • Upgrading existing infrastructures • Implementing merging processes aimed at increasing the competitiveness of research infrastructures at an international level • Carrying out functional interventions for the development of research activities with significant effects on industry and for the business system. 	Budget: EUR 3,8 million 9 financed projects. Declared investments: 7, 8 million euro.
POR FESR 2014-2020 T.O. 2 Digital Agenda			
Infrastructure/Digital Services Project	2014-2020	The t.o. contributes to reduce digital divides in the territories through the deployment of ultra-broad band and the activation of digital services and to digitalise PA internal processes.	Budget: 26 million euros Projects in progress: <ul style="list-style-type: none"> • 234 beneficiary Municipalities; • 2 e-government projects.

POR FESR 2014-2020 T.O. 3 Promoting the competitiveness of small and medium-sized enterprises			
Action 3.1.1 "Aid for investments in machinery, facilities and intangible assets and reorganization and restructuring processes' support"	2016	The action supports the recovery of productive investments, expansive type included, connected to consolidation and diversification processes, to strengthen the regional production base, its technological development, its competitiveness and employment in general.	Budget: 40 million euros 1,255 financed projects. Declared investments: 287 million euros.
Action 3.1.1 "Digitalisation of micro enterprises in inland and non-coastal areas Municipalities"	February 2020	Improving digitalisation level of micro-enterprises in inland and non-coastal areas, to allow better business efficiency and work organization, to develop e-commerce solutions and to take advantage of ultra-broadband connectivity.	Budget: 0.53 million euro 157 funded projects. Declared Investments: 1 million euros.
Action 3.1.1 "Digitalisation of micro, small and medium-sized enterprises"	May 2020 (Edition I) September 2020 (Edition II)	Support micro-enterprises, SMEs, and Liguria professionals who implement their own technology park, support software, hardware or specialist services purchase allowing company efficiency improvement and business continuity through smart working methods, widely used because of the COVID-19 emergency.	Overall budget: 12 million euros 3460 financed projects. Declared investments: over 26 million euros.

Higher education main regional actions	Year	Resources and results
POR FSE 2014-2020 - T.O. 3 "Education and training"		
Higher education intervention projects financed by three-year research doctorate scholarships	2017	Budget: 3 million euros 26 projects submitted for 67 grants. 39 scholarships funded.
	2017	Budget: 3 million euros 29 projects submitted. 21 funded projects. 71% of the financed projects concern a theme indicated in S3, with a prevalence of "Quality of life in the area" (38%). 429 students involved (40% are expected to be employed).
Projects for the implementation of 1st and 2nd level Masters	2018	Budget: 4 million euros <ul style="list-style-type: none"> • Course of action 1 – standard research plans: 3,000,000 euros; • Course of action 2 – strategic research plans: 1,000,000 euros. no. 155 applications received: <ul style="list-style-type: none"> • no. 143 relating to Course of Action 1 (66 funded applications); • no. 12 relating to Course of Action 2 (12 funded applications).
Advanced training intervention projects financed by research grants	2021	Budget: 180,000 euros Funded courses 61 involving 280 workers.
Notice for individual vouchers granted to micro, small and medium enterprises' staff and to individual enterprises who have obtained public funding under the ERDF calls for tenders "Digitalisation of micro, small and medium enterprises", and "Digitalisation of micro-enterprises in inland and non-coastal areas Municipalities"	2021	Budget over 700,000 euro. Positively approved courses 240 (project under construction).

Main regional actions on Research, Innovation, Digitalisation	Year	Resources and results
Smart Cup Liguria	2013-2021	Participants Proposals 276 of which: 210 enterprises and 66 start-ups. Results 32 winners 8 finalists at the National Innovation Award. 1 winner of the National Innovation Award.
	2022 (under construction)	67 proposals 3 finalists 1 winner of the National Innovation Award.
FSC Actions 2007– 2013 Support for the creation of laboratories, university centres and national clusters	2015-2017	Budget for cluster support € 300,000 Support for the launch and consolidation of the following National Technology Clusters: Intelligent Factory, Technologies for Smart Communities, Life Sciences (Alisei). Organization of events on the regional territory, communication support. Budget for the creation of research laboratories: over 1 million euros 3 Laboratories relating to marine technologies. Declared investments: over 2 million euros.
Centre for Human Technologies and technology incubator	2017-2020	Investment: €15.5 million 6,000 m2, 4,500 m2 for the IIT research centre, 1,500 m2 for the Erzelli technology incubator dedicated to start-ups and managed by IIT, Filse and Invitalia. Regional co-financing: 400,000 euros from the Strategic Fund.

CTE 2014-2020			
Priority 1 - Promotion of business competitiveness in the cross-border priority sectors	2014-2020	Increasing the entrepreneurial fabric of micro, small and medium-sized enterprises in the area of cooperation in priority cross-border supply chains, linked to blue and green growth. Strengthen the entrepreneurial fabric of micro, small and medium-sized enterprises in the area of cooperation in priority cross-border supply chains, linked to blue and green growth.	Financed Projects: IT FR Maritime programme: 41 projects €9,292,289.35
Priority 1 – Research and Innovation	2014-2020	Reduce the gaps between the world of research and the business world, promoting the exchange of good practices in the field of technology transfer, innovation mechanisms and methodologies (open innovation, living lab methodology, pre-commercial public procurement, etc.). The topics of innovation mainly concern the sectors identified as strategic to strengthen the competitive capabilities of the more peripheral areas of the ALCOTRA territory such as healthcare, mobility, sustainable tourism, culture and green economy	Financed Projects: Alcotra programme: 8 projects €. 4.066.508,00
Priority 4 - Increase in sustainable and quality employment opportunities and inclusion through economic activity	2014-2020	Strengthen the cross-border labour market in the priority cross-border blue and green growth sectors.	Financed Projects: IT FR Maritime programme: 12 projects € 4.049.769,34

3.2.1 Qualitative analysis of the ERDF ROP measures 2014-2020

In February 2022, Regione Liguria, in collaboration with Liguria Ricerche, started a qualitative survey of some 2014-2020 POR FESR measures, in particular relating to thematic objective I (Research and Innovation) and thematic objective III (Business competitiveness). The main objectives of the analysis were to verify the effectiveness of the interventions and their impact on the territory and beneficiaries and to identify the most frequently encountered difficulties in the process that, from the design of the measures, leads to the granting contributions.

The survey provided on an online questionnaire to all the beneficiaries of the examined measures.

The number of questionnaires sent, the number of feedbacks and the relative response rate follow below:

Actions	No. questionnaire s sent	No. feedback s	Answer rate
Action 1.1.3 - Support for the economic valorisation of innovation through experimentation and the adoption of innovative solutions	168	64	38,1%
Action 1.2.4 - Support for the realization of complex projects of research and development activities	25	10	40,0%
Action 1.2.4 - Support for the implementation of complex research and development projects for companies affiliated to the Research and Innovation Clusters	35	20	57,1%
Action 1.2.4 - Support in carrying out complex research and development projects on a few important thematic areas and in the application of technological solutions functional to the implementation of S3 strategies Complex crisis area of Savona.	4	4	100,0%
Action 1.2.4 - Support for animation, tutoring and support for companies participating in innovation clusters	4	3	75,0%
Action 1.5.1 - Support research infrastructures considered critical/crucial for regional systems	5	3	60,0%
Action 3.1.1 - Digitalisation of micro, small and medium enterprises	2.112	1.024	48,5%
Total	2.353	1.128	47,9%

As evidenced in the table above, the response rate was significant, giving particular interest to the analysis of the responses and the possible consequential directions.

As for the purposes of this document, the results of the measures follow below, leaving out those more transversal results such as the critical issues and strengths found in the management process of the measures.

Thematic object I of the POR FESR 2014-2020 concentrates its resources on strengthening the research and innovation system, as a driver of regional development and territorial competitiveness. Its main purpose is to enhance the elements and specialisations present in the area, as represented in Regione Liguria Intelligent Specialisation Strategy.

Thematic object III goal, particularly the measure analysed (3.1.1), is to improve the level of digitalisation of Liguria micro, small and medium-sized enterprises, promoting innovative models of work organization, to strengthen the production base, its technological development, its competitiveness, employment in general and the continuity of the company's business through smart working methods as a result of the COVID-19 emergency.

To provide a summary of the main results, all T.O.I measures data were aggregated, while measure 3.1.1. was analysed independently.

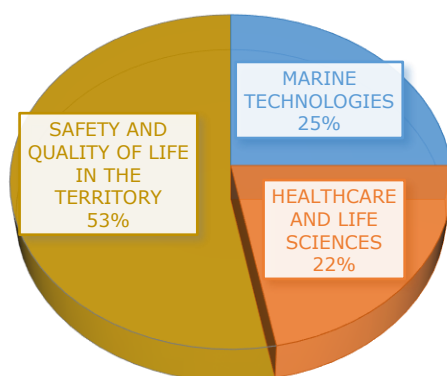
Summary of the main findings

Area of reference of the projects compared to S3 macro-areas

T.O. I ERDF ROP 2014-2020

Out of the 104 questionnaires received, the percentages of projects relating to the three macro-areas of the regional Smart Specialisation Strategy follow in the graph below.

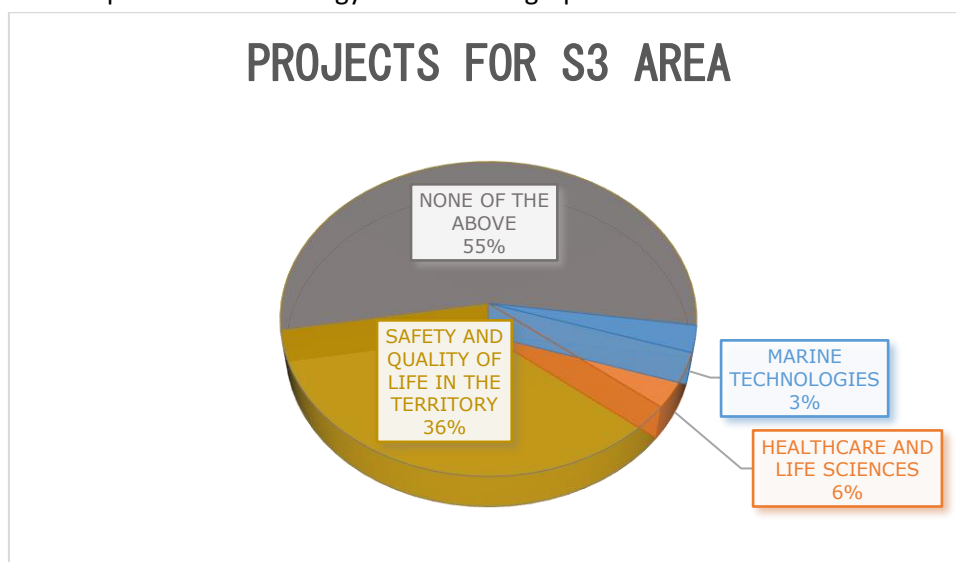
PROJECTS FOR S3 AREA



The subdivision between the three areas is considered balanced, given that the area "Safety and quality of life in the territory" contains a greater number of themes and is in fact overseen by two 2 of the 5 Research and Innovation Cluster of Regione Liguria.

T.O. III – ERDF ROP 2014-2020 (MEASURE 3.1.1.)

Out of the 104 questionnaires received, the percentages of projects relating to the three macro-areas of the regional Smart Specialisation Strategy follow in the graph below.

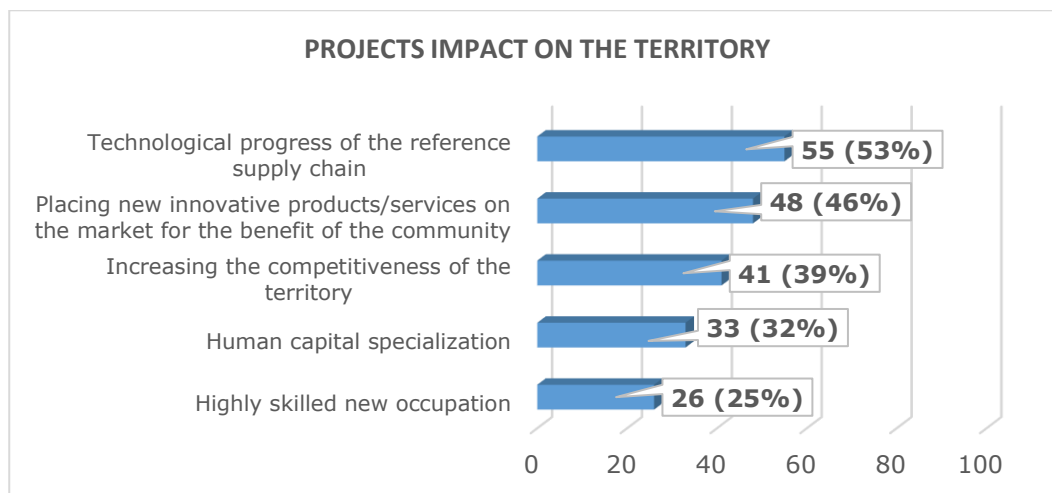


A majority share of projects does not belong to any area of specialisation, which is justified by the fact that the measure is not linked to the areas of specialisation of the Strategy. Among the projects related to the Smart Specialisation Strategy Areas Safety and Quality of life is the predominant area, followed by Healthcare and Life Sciences.

The main impact of the projects on the territory¹⁴

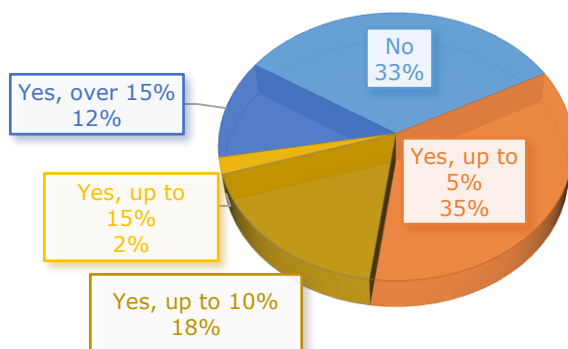
During the survey it was also considered appropriate to analyse which actual results the projects financed by the actions of T.O. I have produced - or could presumably determine -.

The following graph summarizes the information provided by the companies interviewed, which could indicate more than one impact on the territory.



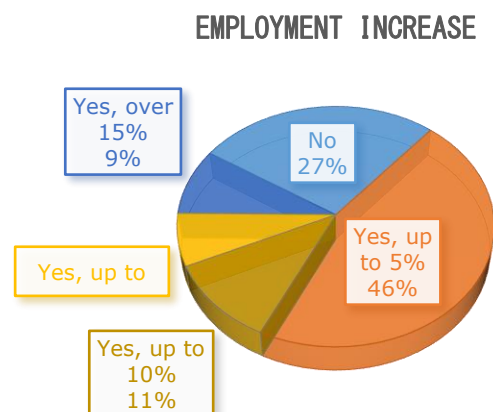
As you can see, for 46% of respondents, the project allowed the development of an innovative product/service to place on the market with a positive effect on the community. This also led to technological advancement of the reference supply chain (for 53% of respondents) with a consequent competitiveness increase in the territory (39% of respondents). Therefore, it can be deduced that the granted funding has actually been used to carry out R&D activities which have led - or which may lead - to new products and services to place on the market for the community benefit and to a consequent increase in competitive and innovative development in the area. Finally, these projects have only partially contributed to the creation of new employment (for 25% of respondents) against a slightly more widespread increase in the specialisation of human capital (32%). The realisation of the projects led to an increase (77% of cases), with a good share of companies that have seen a significant increase (of more than 15%).

SALES INCREASE



¹⁴ The percentages reported in this section may exceed 100% as they relate to multiple choice question results.

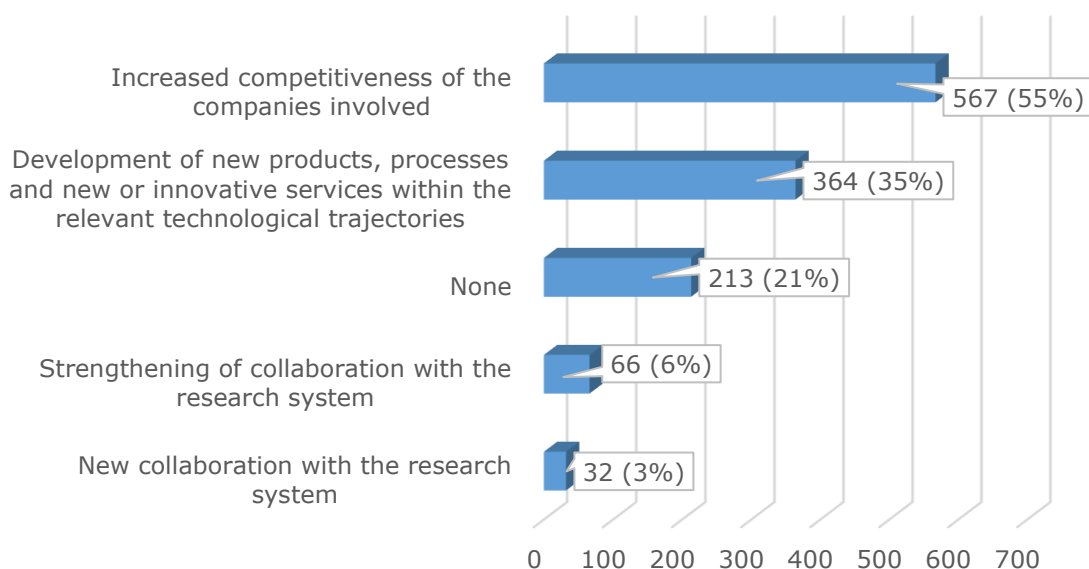
Also, from an employment point of view (not referring to highly skilled employment), the impact of these projects was significant: 73% of respondents saw an increase and 9% recorded a variation of more than 15%.



T.O. III – ERDF ROP 2014-2020 (MEASURE 3.1.1.)

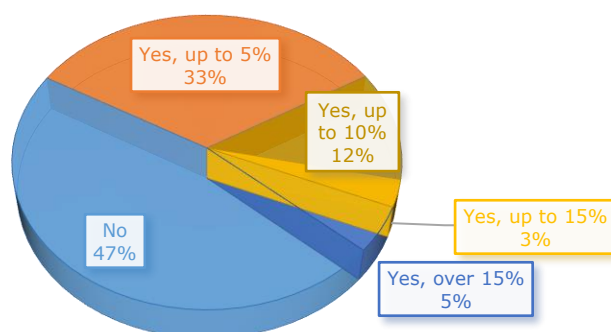
As for the actual impact of measure 3.1.1. Interviewed companies, which could report more than one direct effect of the project, primarily stated that the project enabled an increase in competitiveness (for 55% of respondents) and a development of new products, processes or new and innovative services within the relevant technological trajectories (in 35% of cases). 21% of companies do not detect any direct effect, while there is little strengthening of collaboration with the research system (6% of cases) and the development of new collaborations with it (3%).

DIRECT EFFECTS OF THE PROPOSED PROJECT



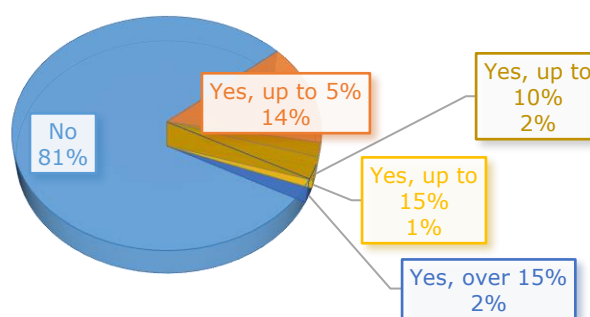
The application of the projects did not lead to an increase in turnover in 47% of cases. On the other hand, 33% of respondents reported an increase, albeit less than 5%. Only 20% show an increase in turnover of more than 5%.

SALES INCREASE



The impact of the projects does not seem significant from the employment point of view either: 81% of respondents did not see any increase.

EMPLOYMENT INCREASE



3.2.2 Qualitative analysis of ESF ROP measures 2014-2020

Again, the qualitative analysis of the actions aims to verify the interventions' effectiveness and their impact on the beneficiaries.

The data relate to the survey carried out in February 2022 by the Regione Liguria, in collaboration with Liguria Ricerche, through an online questionnaire sent to all beneficiaries of FSE POR measures, relating to education and training for the 2014-2020 programming period. In particular, by analysing the measures for research grants and master's degrees of level II and I.

Summary of the main results

As mentioned above, these measures relate to research grants and level I and II masters.

The 24-month research grants follow two different lines of action:

- Line 1. Standard research plans, developed within structured proposals linked to at least one of the mandatory areas of intervention foreseen in 2015-2020 PNR or in the regional Intelligent Specialisation Strategy
- Line 2. Strategic research plans, developed within structured proposals linked to at least one of the regional Intelligent Specialisation Strategy areas and developed within the Research and Innovation Clusters and within one of the projects financed by the ERDF.

In the latter Regione Liguria, by realising level I and II masters, wanted to ensure the training of professional figures responding to the needs of the world of work and of companies operating in emerging sectors in innovation and research. This, by ensuring interventions that, to improve employment effectiveness, include moments of contact with the world of work and encourage the international dimension.

The number of questionnaires sent, the number of feedbacks and the relative response rate follow below:

Actions	No. questionnaires sent	No. feedbacks	Answer rate
Higher education intervention projects related to research grants funding from t.o.3 "Education and training"	55	21	38,2%
Projects for the implementation of Level II and Level I Masters funding from t.o.3 "Education and training"	405	98	24,2%
	460	119	25,9%

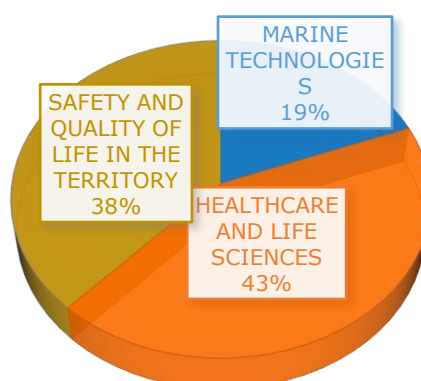
Area of projects' involvement related to S3 macro-areas

RESEARCH GRANTS

Research grants referred to Regione Liguria Intelligent Specialisation areas of the according to the following percentages:

- Healthcare and life sciences 43%;
- Safety and quality of life in the territory 38%;
- Marine technologies 19%.

RESEARCH GRANTS FOR S3 AREA



62% of the research grants concerned Line 1 "Research plans linked to at least one of the mandatory areas of intervention foreseen by the 2015-2020 PNR or the Regional Intelligent Specialisation Strategy". 38% of the research grants concerned Line 2 "Strategic Research plans linked to at least one of the areas referred to in the regional Intelligent Specialisation Strategy and developed within the Research and Innovation Clusters and one of the projects financed by the ERDF".

Among the grants linked to line 1, there is a percentage of referral equal to 25% for DLTM, EASS and PLSV clusters (Liguria Life Sciences) and 12.5% for SOSIA and TRANSIT clusters.

LEVEL II AND LEVEL I MASTERS

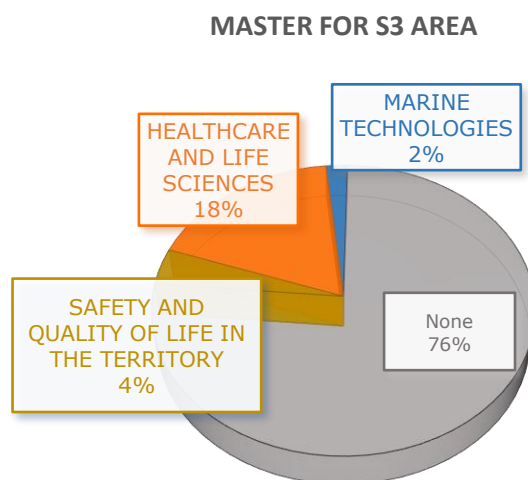
30% of Masters concerned the National Research Programme 2015-2020, while 70% Regione Liguria Smart Specialisation Strategy.

Masters related to 2015-2020 National Research Programme focused on the following areas:

- Smart, secure and inclusive communities (24%)
- Cultural heritage (24%)
- Technologies for living environments (14%)
- Smart factory (14%)
- Design, creativity and made in Italy (10%)
- Agrifood (3, 4%)
- Blue Growth (3, 4%)
- Green Chemistry (3,4%)
- Sustainable mobility (3,4%)

Masters related to Smart Specialisation areas are divided as follows:

- Health and life sciences for 18%;
- Safety and quality of life in the area for 4%;
- Marine technologies for 2%;
- No area for 76%.



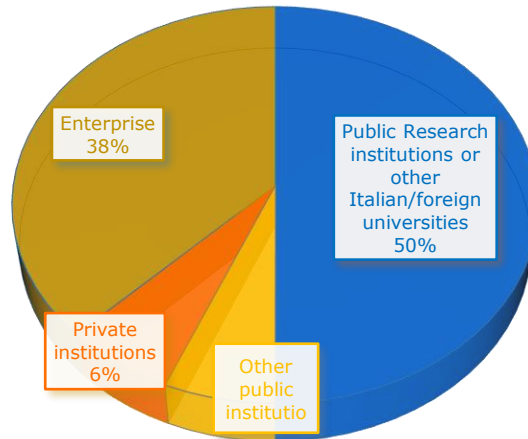
Employment outcomes

RESEARCH GRANTS

76% of respondents stated that they are currently employed as follows:

- 38% Company;
- 50% Public Research Institute or Italian or foreign University;
- 6% Public Administration;
- 6% Private Institution.

EMPLOYMENT OUTCOMES



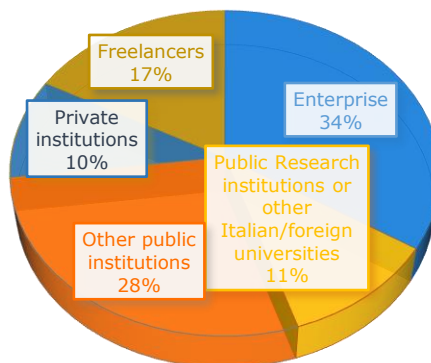
Among those who are unemployed, however, 80% are looking for a job and 20% are studying for a PhD.

II AND I DEGREE MASTERS

91% of respondents stated that they are currently employed as follows:

- 34% Company;
- 11% Public Research Institute or Italian or foreign University;
- 28% other Public Institution;
- 10% private Institution;
- 17% freelancer.

EMPLOYMENT OUTCOMES



Among all respondents currently employed in a company, 57% have a permanent contract.

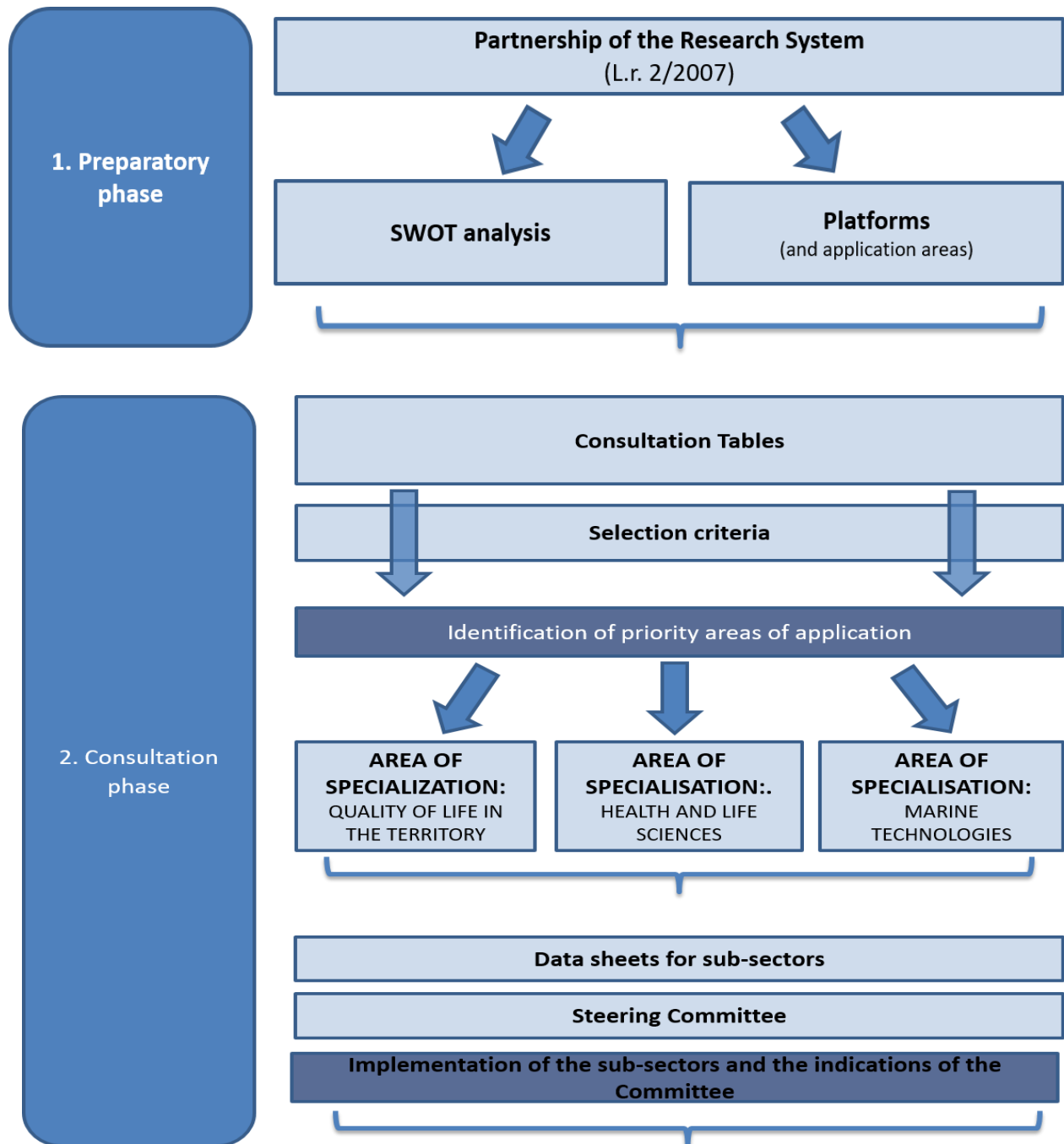
Among those who are unemployed, however, 78% are looking for a job and 22% are studying for a PhD or other Degree.

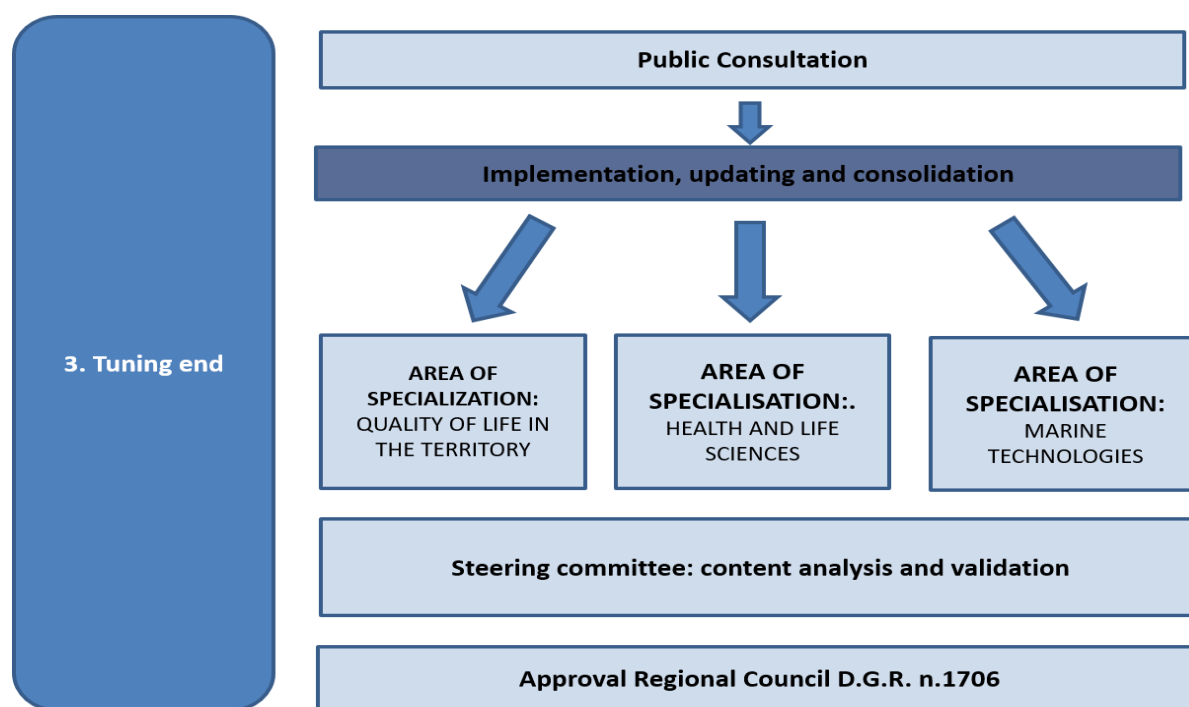
4 ENTREPRENEURIAL DISCOVERY PROCESS

A fundamental phase in building the Smart Specialisation Strategy is the process of listening, consulting and involving the local area and discovering the related entrepreneurial vocations.

The entrepreneurial discovery process implemented by Regione Liguria, based on a *place-based* logic, did not end with the drafting of S3, but continued steadily throughout the 2014-2020 programming period and will continue throughout the new programming period 2021-2027. In fact, the dialogue on innovation and research is a constant element in Regione Liguria industrial and research policy.

An outline of the entrepreneurial discovery process implemented by Regione Liguria in the drafting of S3 2014-2020 follows below:





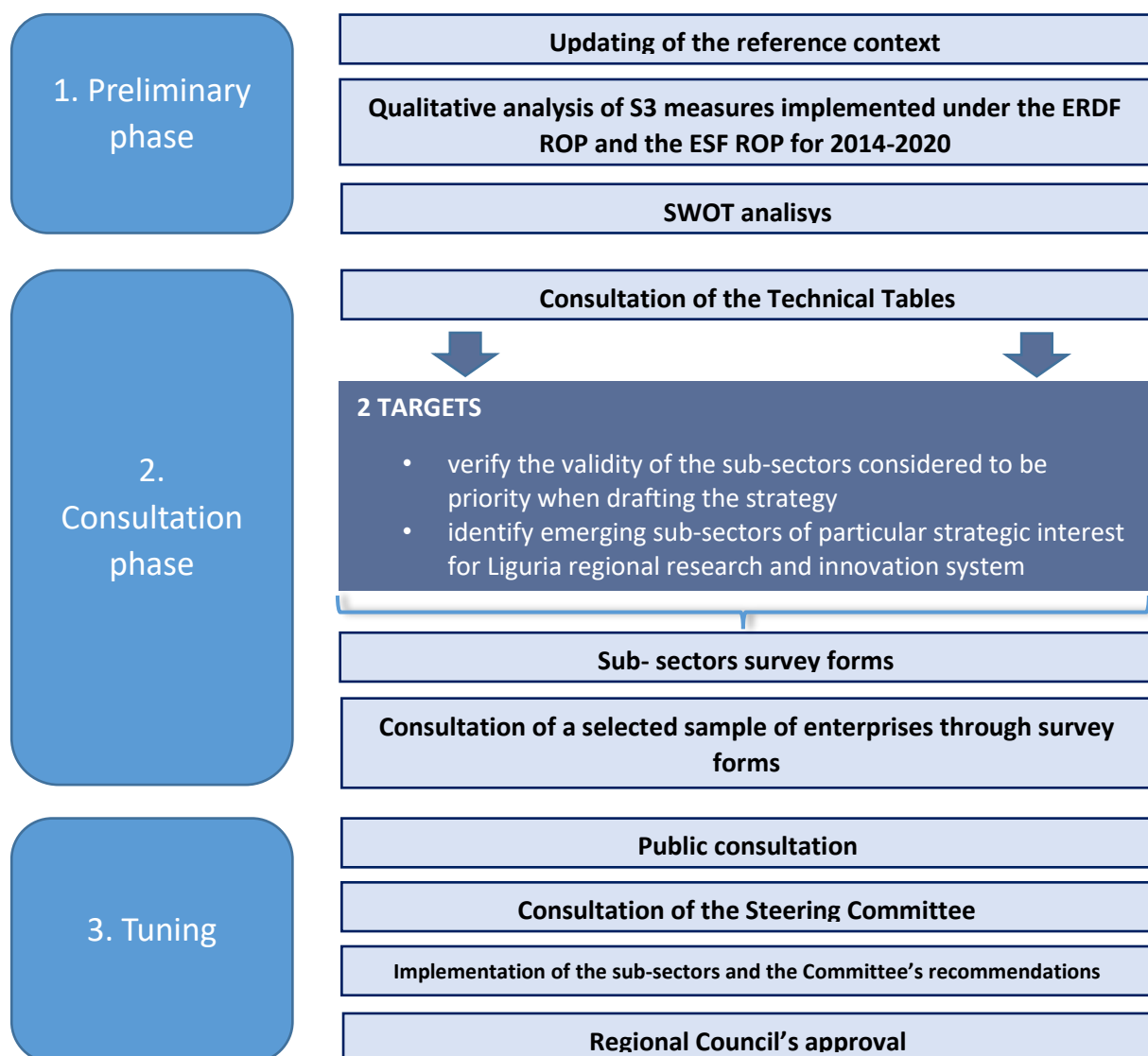
4.1 Entrepreneurial discovery process – 2021 -2027 programming period

A specific consultation activity, based on the entrepreneurial discovery process developed during the S3¹⁵ drafting, was set up in this update. Maintaining a bottom-up approach the process included the entrepreneurial and research world, the 5 Research and Innovation Clusters, thus involving the National Technological Clusters too, the new emerging activities in the area and civil society.

The main objective of the consultation was to verify the permanence of the strategic nature, not so much of the macro-areas that have a structural nature, but of the related sub-sectors (and technological trajectories). In particular, the intention was to verify the validity of the sub-sectors considered to be priorities and to identify, if necessary, the emerging ones of particular strategic interest for Regione Liguria research and innovation system.

As for the process of entrepreneurial discovery that allowed the identification of the specialisation areas of the territory, without prejudice to the methodology identified, during the updating phase the activities were organised as follows:

¹⁵ The latest update of the S3 document has been approved with D.G.R. n.800 of 24 September 2019.



STEP 1. PRELIMINARY PHASE

During the updating step, the **reference context** was analysed with particular attention to the research, development and innovation scenario in order to provide updated reference contexts and collaboration opportunities at an international level. Subsequently, a **qualitative analysis of some of the measures that implemented S3 for the 2014-2020 period followed**, as described in par. 3.2.1. Based on the results of the above elements the **SWOT analysis** followed, which highlights the strengths and weaknesses, as well as the opportunities and threats of the reference context.

On 22 March 2022, the framework of the Smart Specialisation Strategy within the new European programming 2021-2027 was introduced to the **Steering Committee**. It was emphasised its function of enabling condition with respect to the programming of the European Structural Funds and it was also outlined the fulfilment of the criteria identified by the European Commission relating to enabling condition 1 "*Good governance of national or regional Smart Specialisation Strategy*" obtained by Regione Liguria. The Steering Committee was also introduced to the beginning of the monitoring process for S3 and its methodology.

STEP 2. CONSULTATION PHASE

Also, for the 2021-2027 programming period, the three macro-areas of specialisation, have **confirmed priority over time**. This also following the new and updated context analysis performed and the results of the ongoing process of consulting *stakeholders* and entrepreneurial discovery conducted in the area.

Given the dynamism of the context and the emerging priorities, for the period 2021-2027, however, the sub-sectors of the specialisation areas had to be monitored and updated.

The technical consultation process was as follows:

- **Technical Committee consultation:**
 - Research and Innovation Clusters;
 - Research Institutions;
 - Other territorial subjects that, for various reasons, can usefully contribute to the updating process (start-ups, trade associations, ...);
- **Consultation of a selected sample of companies**, by supplying a questionnaire.

As for the **technical tables' consultation**, the parties were submitted survey forms and subsequently had a direct comparison with Regione Liguria, about the confirmation or not of the sub-sectors identified in the previous Smart Specialisation document and about the need to introduce new sub-sectors and highly topical and relevant technological trajectories. Between May and July 2022, a phase of constant confrontation with the above subjects developed.

The survey forms were then analysed to identify a first updated version of the list of sub-sectors and of the relevant technological trajectories for the regional S3.

The **consultation of the entrepreneurial fabric**, on the other hand, took place through a questionnaire given to a selection of a sample of companies. The questionnaire related mainly to their belonging to the sub-sectors and to the technological trajectories identified in the S3 document, updated thanks to the comparison with the technical tables, and the relevance of some new sub-sectors identified.

For the selection of the sample of companies, we started by extracting ATECO codes of the companies benefiting from the actions of POR FESR 2014-2020 tenders on "Research and Innovation", excluding the codes relating to activities that are clearly not pertinent, following a technical evaluation by the working group. The list of codes obtained was compared with ATECO codes of companies adhering to the Research and Innovation Poles and innovative start-ups in Liguria. At the end of this process, we had an overall list containing all the potentially relevant ATECO codes for consultation.

The selection of Liguria companies belonging to the identified ATECO codes (conducted thanks to the database of the Chamber of Commerce system) led to the identification of around 4,000 companies, which were contacted via certified email in the period July-August 2022.

On the expiry date, the questionnaire had 598 respondents with a response rate of 15.3%.

The definition of the sample through the Ateco code methodology inevitably identified a large audience of respondents and not necessarily perfectly relevant to the object of the questionnaire, as also reported via certified email by some potential respondents. The feedback will allow us to refine the selection of codes for any new consultation needs. Given the structure of the questionnaire, the replies received concerned exclusively companies belonging to the S3 specialisation areas.

The replies were therefore analysed to verify the level of reality and interest of the companies with respect to the sub-sectors and the technological trajectories defined starting from the 2019 Smart Specialisation Strategy document, integrated and modified following the comparison with the technical tables. The allowed, in final analysis, to confirm or not the maintenance of each development trajectory in the list.

The methodology already used during the 2019 review was repeated for this purpose, i.e., confirming the trajectories already existing in the previous document if at least 5% of the respondents had identified them as pertinent. Similarly, the new trajectories identified by the Technical Tables were maintained with respect to the 2019 document if at least 10% of respondents had identified them as pertinent trajectories. During the results' analysis, it was appropriate to bring together some technological trajectories previously detailed by the Technical Tables, given that the excessive detailed level did not allow us to grasp the relevance of the trajectory as a whole.

For the new sub-sectors proposed by the Technical Tables, then, the criterion was envisaged according to which the specific technological trajectories would be included if the responses of interest were higher than those that signalled a lack of interest. In addition, however, we used the correction of the unification of some technological trajectories since the detailing sometimes did not allow the achievement of a sufficient critical mass.

The application of this methodology led to the definition of the definitive list of sub-sectors and related technological trajectories.

STEP 3. TUNING PHASE

At the end of the previous phase of technical consultation, we proceeded with the public consultation. It is important to involve in the process those who benefit from research and innovation, groups that represent the demand needs, consumers and non-profit organizations representing citizens and workers. For this purpose, we then proceeded with the elaboration of a questionnaire that was widespread throughout the territory, in particular by:

- Institutional channels (website, newsletter (about 38,000 subscribers), Facebook page, mailing list, etc.);
- Regione Liguria investee companies' institutional channels
- institutional channels of some of the stakeholders who are part of the Steering Committee;
- communication in local thematic magazines;
- Banners in online newspapers of regional importance.

The main results follow below:

The public consultation started on 26 October 2022 through the online publication of a questionnaire on S3 issues that remained active until 5 December 2022. 619 subjects completed the questionnaire: 82% replied to the questionnaire in a personal capacity and 18% replied as a representative of an organization (institution, company, etc.).

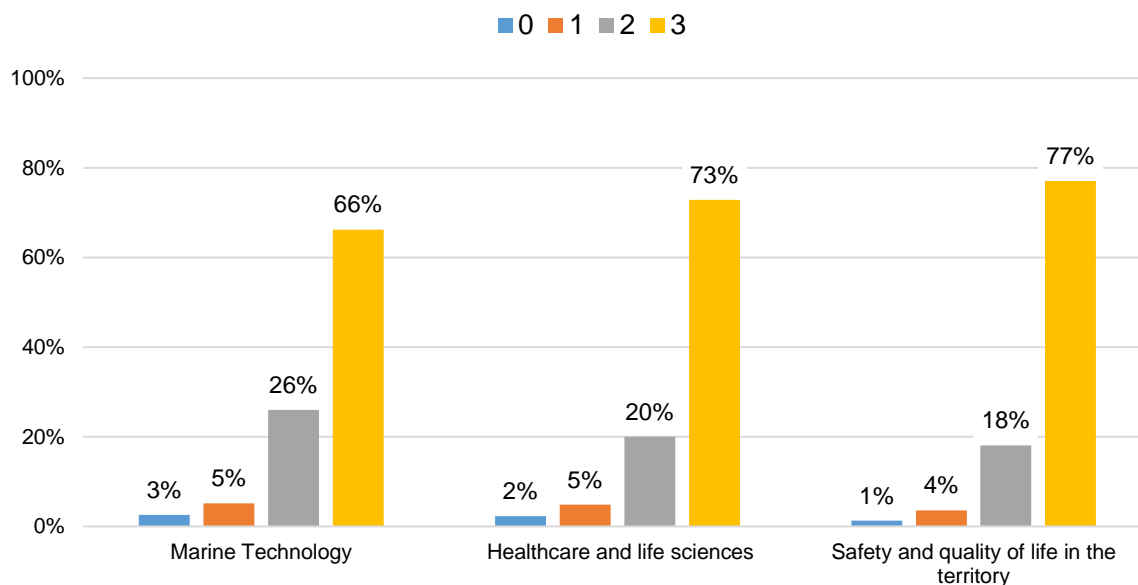
Among the respondents **on a personal basis**, 26% were **aware of the Smart Specialisation Strategy**, mainly thanks to the following **channels**: institutional websites, Por FESR newsletters, social media and regional tenders.

Among the respondents **representing an organization**, the share of subjects aware of the Strategy is higher and corresponds to 46%. Of these 60% have been directly involved in projects under the regional S3 and 78% are aware of the Strategy update process.

Respondents were asked to quantify, on a scale ranging from a minimum of 0 to a maximum of 3, how important they considered the **strategic areas identified for Liguria territory**.

Most respondents, both personal respondents and those representing an organisation, consider the areas identified to be truly relevant, assigning a score of 3: Marine Technologies (66%), Healthcare and Life Sciences (73%) and Safety and Quality of Life in the Territory (77%). In particular, the area of Safety and Quality of life in the Territory has the largest share of subjects who attribute it a value of 3.

How important do you think the identified strategic areas for the Ligurian territory are?



Among the elements relating to the research and innovation system that are particularly important for the competitiveness of the territory, the following stand out:

- The specialisation of human capital (stated by 53% of respondents);
- Partnerships between the university system and local public and private stakeholders (51%);
- The increase in public spending on R&D (49%).

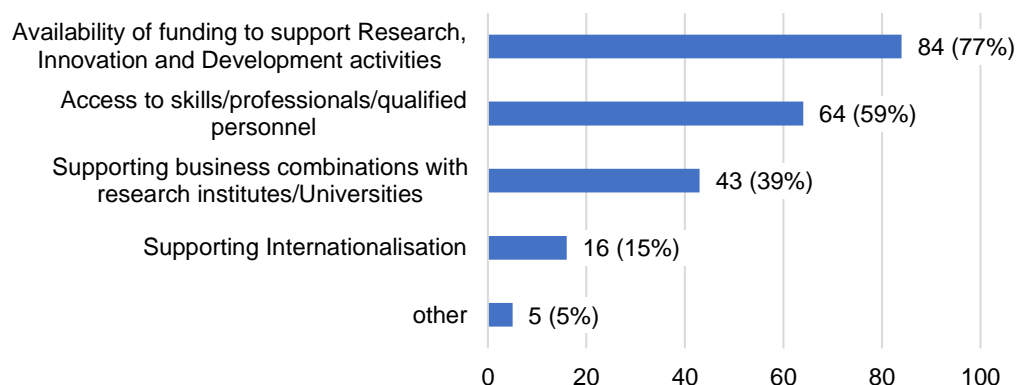
Among the subjects who responded on behalf of an organization, the presence of companies in the high-tech manufacturing industry is also significant (stated by 53% of respondents).

On the other hand, the presence of certified business incubators (25%) and the registration of trademarks and patents (21%) are relatively less significant.

The subjects who responded on behalf of an organization stated as strategic **elements to promote innovation activities in particular:**

- The availability of funding to support Research, Innovation and Development activities (77% of subjects);
- Access to skills, professionals or qualified personnel (59% of subjects).

What elements do you consider most relevant to foster innovation activities?



Multiple-choice questions.

Following the public consultation, on 5 December 2022 the definitive structure of the document and the main evidence deriving from the entrepreneurial discovery process were submitted to the **Steering Committee** pursuant ex lege no. 2/2007, previously informed on the methodology adopted for the entrepreneurial discovery process.

As for the 2014-2020 programming period, also for the 2021-2027 period the consultation and comparison process with the main subjects operating on the territory in the S3 areas will be continuous over time, to guarantee an always-updated snapshot of the context of reference.

5 SWOT

STENGTHS	WEAKNESSES
MAIN ELEMENTS OF THE SOCIO-ECONOMIC CONTEXT	
<ul style="list-style-type: none"> • Employment and activity rates above the national average • Decrease in the unemployment rate ^(a) • Increase in regional GDP, added value and household consumption * • Growth of gross fixed investments more intense than that of the reference contexts * • Increase in export flows *** • Significant increase in regional exports of high-tech manufacturing industry *** 	<ul style="list-style-type: none"> • Population decrease compared to 2012 • Old age index much higher than the national and North-West average • Negative total population growth rate • Very small size of companies • Low ability to export if exports are compared to the regional GDP
RESEARCH AND DEVELOPMENT	
<ul style="list-style-type: none"> • Active and diversified research funding system • Increase in total intra-mural R&D expenditure and in the incidence of R&D expenditure on GDP** • Increase in the number of research and development personnel* • University system active in Regional Research and Innovation Poles and in the National Technological Clusters • Collaborations between the university system and various local public and private stakeholders • Active collaboration between the various local actors of the quadruple helix in territorial cooperation projects in the field of applied R&D 	<ul style="list-style-type: none"> • Decrease in the number of companies that conduct R&D activities in collaboration with external parties* • Small number of registered patents, trademarks and designs

INNOVATION	
<ul style="list-style-type: none"> • Increase in the innovation rate of the production system ^(b) • Higher spending on innovation per employee at national level • Active collaboration between the various local actors of the quadruple helix in territorial cooperation projects on the subject of innovation 	<ul style="list-style-type: none"> • Low incidence of innovative start-ups and innovative SMEs compared to other Italian regions • Decrease in the number of active technology companies*** • Low birth rate of enterprises in knowledge-intensive sectors
DIGITALISATION	
<ul style="list-style-type: none"> • Full coverage via broadband connections in municipal administrations • High availability of public Wi-Fi in Liguria municipalities • Percentage of households with Internet access above the average figure for the two reference contexts and increase in Internet use in the last 3 and 12 months*** • Increase in online sales via web and/or EDI-type systems*** • Good Internet connection speed in businesses 	<ul style="list-style-type: none"> • Low use of e-procurement • Low percentage of Municipalities with fully interactive services • Low percentage of population that uses the Internet to interact with the Public Administration • High percentage of population "lacking any digital skills" • Low adoption of enabling platforms and digital tools such as cloud computing by businesses
MAIN RESULTS OF THE 2014-2020 PROGRAMMING	
<ul style="list-style-type: none"> • Placing new innovative products/services on the market • Technological advancement of the reference supply chain • Increase in turnover • Increased employment • Increase in the competitiveness of the beneficiary companies • Acquisition of new knowledge and skills useful for employment purposes 	<ul style="list-style-type: none"> • Improvable impact of increasing human capital specialisation

<ul style="list-style-type: none"> • Expansion of job prospects including long-term employment • Comparison between professionals and new realities, networking possibilities • Broad and active participation in ETC programming with direct effects on innovation and skills increase for the actors involved 	
<p>* Period 2015-2019; ** period 2015-2020; *** period 2015-2021; (a) period 2018-2021; (b) period 2014-2020</p>	

OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> • Numerous initiatives promoted at European level aimed at supporting innovation in the field of social challenges (<i>demographic ageing, climate change and scarcity of resources</i>) • Exploiting the catalyst function of the Public Administration to encourage digitalisation also in the private sector • Leverage the sustainable business models of national and regional public institutions • Exploiting the growth of online sales and the propensity for e-commerce to support companies' digital transformation 	<ul style="list-style-type: none"> • Socio-economic context affected by the Covid-19 pandemic • International political instability linked to the Russian-Ukrainian conflict • Difficulties in energy supply at an international level • Competition from other countries in production costs and ability to attract highly qualified human resources and capital • Strong attractiveness of productive investments from neighbouring regions • Reorganization and relocation processes to which multinationals are often subjected

6 LESSONS LEARNT

Concerning the lessons learnt in the 2014-2020 programming period, the main findings follow below.

As for the actions conducted in the period 2014-2020, it should be noted that:

- **The digitalisation diffusion process** continued and strengthened compared to the previous programming. However, there are still signs of delays in the deployment and use of digital technologies, both for businesses and for citizens and public administration. It follows, therefore, also in the light of the new needs emerged in recent years, the need to further strengthen the process undertaken, in order to make the territory increasingly competitive;
- The **measures in support of Innovation clusters** have met particular interest. They are groupings of independent companies, innovative start-ups, small, medium and large enterprises, research organizations active in a particular sector or territorial area. Their intention is to stimulate innovative activity by encouraging intensive interaction, the shared use of facilities and the exchange of knowledge and experience. This effectively contributing to technology transfer, networking and dissemination of information among the companies that make up the Cluster. These interventions have strengthened and improved the innovative capacity of the territory.
- Among the **most successful tenders** there are, in fact, those reserved for companies aggregated to the Research and Innovation Clusters: thanks to their support, companies can submit more complex projects that well express the company's needs while, at the same time, meeting the technological trajectories identified by the S3. The support of the Innovation Clusters and the design constraint to the S3 represent the most prominent facilitating elements for the achievement of the objectives of the POR;
- In the 2014-2020 programming period, **the reference framework for research and innovation has improved**, with an increase both in expenditure and in the number of staff working in this sector. The research and innovation activity represents a strategic element to support the competitiveness of Liguria economic system, also improved in the 2014-2020 programming period;
- Thanks to the actions implemented in the 2014-2020 programming, companies have introduced new innovative products/services on the market, which have allowed them to **increase their level of competitiveness** and, consequently, to positively influence the technological advancement of the supply chain;
- With regard to higher education, the provision of research grants and master's degrees has enabled beneficiaries **to broaden their long-term employment prospects** through the acquisition of new skills and above all, it has allowed greater networking among industry figures;
- As for the procedures relating to 2014-2020 actions in the field of research and innovation, the main elements for improvement detected through a questionnaire administered to the beneficiaries of the POR FESR t.o. I and t.o. III are:
 - Simplification of procedures and documentation, both in the application submission phase and in the reporting phase;
 - A simplification of the online tender portal;
 - Faster times both in the granting and disbursement phases.

As for the processes of implementation, creation and monitoring of the S3 document, note that:

- The **entrepreneurial discovery process** was indeed effective, not only in the phase of identifying strategic areas but also in the updating and monitoring one, however it highlighted the need to expand the civil society participation. In fact, it is important to involve in the process also those who benefit from research and innovation and the groups that represent the demand need. It emerged also the necessity for a formal involvement of the National Technological Clusters, in order to have perfect coherence with strategies and guidelines at the national level;
- **Communication between subjects of the regional research system**, which for several reasons are involved in the realisation of S3, has not always been quick and efficient. That's why it is deemed necessary a greater use of information technologies available in order to encourage continuous discussion within the research system and a meetings annual timeframe of technical tables;
- As for the **monitoring and evaluation tools** aimed at measuring the performance with respect to the strategy objectives, the use of the NUVEC-IGRUE monitoring process, adopted at national level, has allowed:
 - an overall view for each thematic area of the kind of projects financed by the national strategy,
 - data usage comparable to regional ones by area of specialisation that previously were not available,
 - the returning of comparable information in terms of business typology, demand for innovation and development trajectories at local level,
 - sustaining policy decisions concerning the definition of appropriate tools aimed at supporting the innovative capacity and competitiveness of companies at national and territorial level.

To have a broad and contextualised information base it was introduced a monitoring dashboard with specific indicators and data relating to the areas of specialisation. This implementation is also in compliance with a specific recommendation of the European Union regarding the need for constant monitoring of the indicators performance, able to allow the appropriate periodic assessments of the strategy performance (see chap. 9.2).

- the 2014-2020 experience has shown how the implementation of the S3 can be more effective if supported by **interregional and international cooperation measures** and by its involvement in territorial cooperation programs (CTE).

We highlight the following elements:

- Intensify the presence of the Liguria Region within the S3 thematic platforms;
- Strengthen synergies with territorial cooperation projects and, in general, with directly managed European projects.

7 REGIONE LIGURIA SMART SPECIALISATION MACRO-SECTORS

Based on the context analysis and the process of consultation and participation of research and innovation system stakeholders in the strategy definition phase, three areas of smart specialisation have been identified for Regione Liguria:

- Marine technologies
- Safety and quality of life in the territory
- Healthcare and life sciences.

These three areas confirmed their priority position over time, also following the new and updated context analyses and the results of the ongoing stakeholder consultation and entrepreneurial discovery process conducted in the territory.

Therefore, a picture of the smart specialisation areas updated according to what emerged in relation to the most recent stakeholder consultation follows below.

7.1 Marine Technologies

The marine technologies macro sector includes the protection of the marine environment, all activities relating to the ship itself (shipbuilding, services, refitting), to the port (logistics, security, controls) and to services with high added benefits (integrated logistics).

Blue Economy, as a whole, produces a benefit of 3.4% of GDP at a national level (year 2020)¹⁶.

The topic of economy and technologies of the sea plays an extremely significant role in Liguria from an industrial point of view, services and technological development and represents a competitive cluster for the territory to be preserved and strengthened.

The strategic role of Liguria in maritime activities is stated in the X Report on the Economy of the Sea, drawn up by Unioncamere and the Tagliacarne Institute. The report shows how, looking at how much the sea economy contributes to the added benefits in the regions, the first place goes to Liguria, where the Blue Economy accounts for 14.5% of the total regional added value (year 2020), more than double the share the second ranked region, Basilicata (6.6%). Friuli Venezia Giulia ranks third (5, 8%). In Liguria, the handling of goods and passengers via sea is the main wealth source (representing 55.4% of the regional benefit due to blue economy).

Liguria also ranks first for the number of Blue Economy employees, with a value equal to 11.9% (year 2020).

From the provincial analysis of absolute value data of the sea economy, Genoa ranks second, after Rome, and contributes 9.1% in terms of added benefits and 8.5% in terms of workforce to the overall wealth produced by Blue Economy in Italy.

On the other hand, if we compare wealth and employment generated by maritime economy to the total of the provincial economy, the province of Genoa leaps to first place. In detail, the incidence on the provincial total is equal to 18.4% in terms of benefit and 20% in relation to the employment weight.

The following provinces, in both rankings, differ significantly from the first ranked. As regards the benefit, Trieste, Gorizia and La Spezia (12.3%) follow. As far as employment is concerned, La Spezia (13.7% the weight of the employed on the total provincial employment), Rimini and Gorizia follow.

Liguria is the first Italian region also for the incidence of blue companies on the total economy, with a value that reaches 10.3% (year 2021). Sardinia follows at a distance, with an incidence of 7%.

¹⁶ X Report on Marine Economy, Unioncamere and Centro Studi Tagliacarne, 2022.

All four Liguria provinces, La Spezia, Savona, Genova and Imperia, are among the top ten by incidence of marine economy enterprises on the total number of provincial enterprises. La Spezia ranks first with an incidence of 15.6%, thanks, mainly for tourism and for the shipbuilding supply chain. The other Liguria provinces rank sixth (Savona), ninth (Genova) and tenth (Imperia). The first ten provinces in terms of number of *Blue Economy* enterprises contain, overall, 46.5% of the total of marine enterprises at national level. The province of Genoa is also fourth in the provincial ranking for the absolute number of marine economy enterprises (7,865).

Note that, between 2019 and 2021, the national entrepreneurial base of the Blue Economy recorded a growth of 2.8%, +6,104 companies, in contrast with the total economic contraction observed. This positive data of the "maritime system" is the result of two consecutive years of increase.

The sector that recorded the most substantial increase is research, regulation and environmental protection (+5.5% between 2020 and 2021). Businesses also increased in the sectors of accommodation and food services and the movement of goods and passengers by sea. Sports and recreational activities and shipbuilding showed a more fluctuating trend, while the dynamics of fishing industry and marine extractions were negative.

Overall, in 2021 compared to 2020, Liguria recorded an increase in maritime economy enterprises of 1.2%. Finally, all four Liguria provinces are in the top ten Italian provinces by incidence of shipbuilding exports on the total provincial exports. Genova (15.7%, sixth place), Savona (9.5%, eighth place) and Imperia (6.0%, tenth place) second among the Italian provinces, with an incidence of 44.6 %, follow La Spezia (year 2021). The provinces of Genoa, La Spezia and Savona also appear among the top ten provinces by absolute value of shipbuilding exports to Italy.

It is particularly important the presence of large industrial groups in the shipbuilding and ship repair sectors, which promoted the development of highly specialized and competitive supply chains with the presence of numerous SMEs, which have always continued to invest in product and process innovation. Following the economic crisis of the first decade, the sector underwent a profound transformation. Nevertheless, it has maintained project skills and abilities able of competing at an international level, which must be preserved and supported through innovation processes strongly oriented towards sustainable products and that respond to the challenge of the efficiency and sustainability of maritime transport.

It should also be highlighted that, alongside the production and refitting of recreational crafts and large ships, a further fundamental asset for Liguria economy is represented by the ports of Genoa, La Spezia and Savona, for which a further substantial development of cruise activities and activities related to logistics, security and automation in port areas is foreseen. At the same time, in Liguria, this sector represents the expression of a demand for technology and new products and a production capacity in the field of automation, robotics and sensor technology, historically in the area and still able to compete on national and international markets.

Also, in this area it should be highlighted the need to support the development of innovative technologies and processes capable of making the activities connected to the port more sustainable from an environmental point of view.

For the reasons set out above, the following sub-sectors were identified with reference to the area of specialisation:

Maritime Technologies

The sub-sector, compared to the developments in the European, national and regional context of reference, essentially represents an evolution and updating of the previous sub-sector dedicated to "Maritime technologies" foreseen for the 2014-2020 programming period.

The technological trajectories remain almost unchanged, but with a greater focus on improving the ship's energy efficiency and sustainability, also using new technologies in the production processes. Particularly important is the use of robotic technologies, digital twins and Artificial Intelligence (AI) that, if used in the various planning, production and operation phases, can contribute to improving the environmental and economic sustainability of the ship and at the same time increase the competitiveness of the shipyards themselves.

The shipbuilding industry, at a regional and national level, is in fact moving increasingly towards the design of efficient ships with low environmental impact, safe, connected, self-sufficient and able to acquire environmental measures along the way. Technological development in the marine robotics sector aims at integrating multiple systems able of performing different operations in the air, on the water surface of and under water. Shipbuilding infrastructures are moving towards the improvement of safety, sustainability and efficiency. Technologies and applications related to the "Industry 4.0" paradigm (Digital Twin, Internet of Things, use of autonomous and robotic systems, cloud computing, etc.) are introduced into the reality of the shipbuilding and nautical industry.

These technologies constitute an extremely important aid for the construction and maintenance worlds, including simulation and training, and are the basis of an ever more intense integration from ship production to ship in service.

For the shipbuilding industry in Liguria, the priority activities concern the construction of cruise ships, military surface units and submarines, dual technology ships, naval components, as well as research and innovation activities of companies, universities and public and private research centres. Equally important is the production of motorboats larger than 60' and mega yachts, with particular attention to offshore sailing and vintage sailboats restoration, ship repair and conversion and marine systems.

In this regard, the pleasure boating sector has a strategic importance, headed by design studios, shipyards to produce sailing and/or motorboats, companies specialising in fitting and furnishing on board, sail factories, companies operating in the sectors of maintenance, repair and refitting services and in logistic assistance, mooring and storage services. In addition to the traditional shipbuilding industry, in recent years has increasingly strengthened the presence on the territory of well-established companies in design and construction of remotely or self-piloted surface and submarine vessels, destined to play a key role in maritime operations in the future.

Safety and enhancement of the marine-coastal environment

Ports, marinas and seafront construction-site areas generate, by their nature, a high environmental impact due to the concentration of activities that take place and to the volume of traffic connected to on-site handling and processing. The effects produced on the environment are particularly complex, due to the plurality of polluting factors that come into play: air pollution, water pollution, pollution due to the movement of toxic substances, noise pollution near shipyards and port terminals. Technological development is the most effective tool for slowing down the growing pace of environmental damage, managing environmental emergencies and restoring interventions also extended to coast/river interaction. This can be achieved both through the implementation of ecological restoration works of ecosystems and species and through the restoration of biodiversity and ecosystem services, and for the study of marine biodiversity and ecosystem services as inspiring elements to produce new materials and new compounds.

The protection of habitats and marine biodiversity is in fact fundamental for the achievement and maintenance of Good Environmental Status (GES - Good Environmental Status, as defined by the EU Marine Strategy Framework Directive) and for a sustainable management of the use of the sea which guarantees ecosystem services. The "Marine Environment and Coastline" trajectory of Blue Italian Growth (B.I.G.) Technological Cluster therefore focuses on issues related to the integration of marine observation systems and technologies for a sustainable use of the marine environment and for the mitigation of impacts. High-tech marine products and services are emerging industries of the global and Mediterranean economy, helping to increase knowledge and improve decision-making processes. However, Italy does not currently have an integrated observation system that responds to both local and national needs and the management of the maritime space and coasts is still not very efficient and effective. It is therefore necessary to enhance control systems, in particular environmental and marine monitoring ones, including AI-based systems and marine litter systems. At the same time, it is also necessary to promote multidisciplinary research and to integrate the world of research with the industrial one.

In terms of environmental sustainability, it is essential to consolidate the green port interventions that the Liguria port system has already started. Green ports, in fact, represent technological platforms, a place for pilot actions experimentation too, which implement circular economy models to support coastal and port environmental sustainability, with interventions related to waste collection and management (for example, Decree Law 197/2021 on ports' charging) and to energy management (for example, through the energy community tool).

One of this area's interventions is cold ironing, i.e., the construction of systems for supplying electricity to ships docked in ports from the shore, so that on-board generators can be switched off, eliminating emissions into the atmosphere and mitigating the acoustic impact. Other measures concern innovative propulsion technologies, such as the use of new energy vectors, for example hydrogen, with a reduced environmental impact, which represents a possible turning point, but requires a rethinking of port infrastructures.

Ultimately, the maritime industry is still at the beginning in the process of applying circular economy principles throughout the ship's life cycle. At the same time, it is facing a rapidly evolving landscape of decarbonisation, a fleet global growth and the need to increase ship-recycling capacity, regulatory changes and transition towards global sustainability. These circumstances present an opportunity for the shipping industry to apply the principles of circular economy throughout the whole ship's life cycle.

Logistics, safety and automation in port areas

Port areas present very particular logistics, security and automation problems, linked to the specific infrastructures, to the naval and land vehicles that operate in close contact, to the specific activities carried out within the port border. At the same time port areas have strong interactions with external processes, especially when, as in Liguria, ports are located within the urban context that conditions and creates conditionings. The increase in the demand for the mobility of goods and people that has characterized the last few decades and will continue in the future generates, on the other hand, a high external cost for the community in terms of quality of life, safety and pollution. For these reasons, in line with the priorities defined by the National Transport and Blue Growth Clusters and with European guidelines, the strategic priorities for the sector concern the safety of naval units and, in general, of all logistics flow operators. This is possible by implementing systems and technologies capable of optimizing logistic routes and the planning of port-terminal transits and thanks to the adoption of the most modern information technologies (ICT, Big Data Analysis and Internet of Things) capable of making the fully traceable and programmable goods route. At the same time, it is important to reduce the environmental impact of maritime and port traffic, also in relation to potential risks of spills and coastal pollution.

Marine Technologies – Synthesis Framework

MARINE TECHNOLOGIES	
R&D system specialisation level	High
Local needs	<ul style="list-style-type: none"> • Improve the environmental and economic sustainability of the ship • Support and consolidate the economic activities connected to port areas and specialised services with high benefit in a period of generalized economic crisis • Coping with the high and complex environmental impact deriving from port activities, due to the business concentration and traffic volume • Manage the problems due to the interaction between the port system and the urban fabric in terms of logistics, safety, and quality of life • Ensure the possibility of increasing traffic from a sustainability perspective
Strengths and competitiveness of the territory	<ul style="list-style-type: none"> • Presence of the major Italian port system • Tourist vocation • Specialisation in shipbuilding, logistics, manufacture of means of transport • Strong tradition and history in manufacturing (Institutions and companies) • High competitiveness both on the national and international market with avant-garde solutions and products • Good availability of technological skills • Collaboration and synergies among subjects • Good competitive positioning both at national and international level in research activities
Impact	<p>The impact of technological and industrial solutions connected to the area of specialisation is extremely broad and affects the following sectors:</p> <ul style="list-style-type: none"> • Tourism • Building systems and furnishing components • Domotics • Industrial Design • Eco-sustainability and protection of the marine environment
Territorial pervasiveness	Whole region
Sub-sectors	<p>Maritime Technologies</p> <ul style="list-style-type: none"> • Energy efficiency of naval and nautical means • New eco-sustainable processes and technologies for shipbuilding (with attention to the entire ship's life cycle) and ship repair • Reduction of the environmental impact of naval and nautical vehicles, including acoustic pollution • Safety, Cyber security and ships and port infrastructures' automation: new technologies for command and control in maritime scenarios with the possibility of unexpected or anomalous events, aiming the goal of autonomous ship, with decision support • Advanced maritime infrastructure, including e-Maritime solutions • Innovative solutions for the design, validation and creation of new materials and components resistant in the marine environment and development of

	<p>environmentally friendly technologies for the protection of materials in the marine environment</p> <ul style="list-style-type: none"> • Domotics, Digitalisation, IoT and Smart Ship • Development of innovative services (after sales) and related enabling technologies • Systems for predictive maintenance of on-board equipment and systems (<i>Life Cycle Cost Analysis</i> and <i>Condition Based Maintenance</i>) • Robotic systems and instruments and their subsystems in the underwater environment to operate in the depths, particularly in coastal areas, ports and <i>offshore</i> infrastructure • Innovative design for the nautical industry and <i>refitting</i> • Development and application of enabling technologies of Industry 4.0 to shipbuilding (robotics, <i>digital twin</i>, AI e <i>Big Data</i>) <p><i>Protection and enhancement of the marine-coastal environment</i></p> <ul style="list-style-type: none"> • Development and application of environmental and marine monitoring systems, including AI-based systems and marine <i>litter</i> systems • Weather-marine modelling, measurement and modelling of wave motion and currents and sea level • Green ports, <i>cold ironing</i>, ships electrification, green <i>propulsion</i> and circular economy models • Development and use of technologies and biotechnologies for the management of environmental emergencies and of restoration interventions extended also to the interaction coast/rivers <p><i>Logistics, security and automation in port areas</i></p> <ul style="list-style-type: none"> • ICT for the management of port logistic process • <i>Safety, Security, Cybersecurity</i> and <i>Biosecurity</i> in ports and interports • Systems and technologies for the management and automation of port activities and port access gates • Ship-terminal freight traffic planning and management • Integration between port logistics systems and port and maritime navigation monitoring systems • Maritime and port traffic control systems • Study of innovative technologies and strategies for the management of the coastal area and marine anthropic impacts, particularly in the port area (port/city/highway/railway interaction, dredging, <i>marine litter</i>, <i>oil spill</i>)
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7.2 Safety and quality of life in the territory

Compared to the 2019 Strategy Document, after the entrepreneurial discovery process, the sub-sectors and the related technological trajectories of the area have been reviewed and updated, also in terms of nomenclature, both with respect to the priorities of the seven-year period 2021-2027, and with respect to the new technological focuses of the scientific and entrepreneurial fabric. In this regard, it became necessary to insert a new sub-sector focused on space economy applications and, in particular, on downstream applications where Liguria has excellence at a scientific and industrial level.

In general, the area of specialization refers to the adoption of innovative models aimed at identifying application solutions for the development and overall management of urban/metropolitan areas and the territory in general. Particular attention is paid to smart mobility of goods and people, to energy systems, to the relationship between public administrations and citizens and to safety. In terms of safety (safety & security), the concept extends to the monitoring of the territory and the prevention of critical or risk events, to the environment and to critical infrastructures. Furthermore, great consideration is devoted to the IT security of data and their use, to production systems related to Industry 4.0, to industrial automation, to the bio economy, reuse techniques, and to applications related to the space economy.

From a social point of view, the goal is to promote effective public-private collaboration, to allow the development of technological and application solutions to improve the citizens' quality of life, to influence economic growth of the territories with particular attention to the environment and to increase the competitiveness of the territory in the national and European context.

Territorial development, in general, cannot ignore a strong connotation based on sustainability (economic, social, and environmental) and the fight against climate change. Therefore, the activities of the world of research and industry are strategic, consistent with the technological trajectories dictated at Community and national level (National Research Programme 2021-2027), which provide, for example, the application of processes typical of the Circular Economy and the vision of a society based on the Bio economy. In this instance, the goal is to improve and increase the use of renewable resources, in order to face global and local challenges such as climate change and sustainable development.

In Liguria, the needs expressed by the territory in terms of safety, transport system, mobility/logistics, environment, energy efficiency, industry 4.0, etc. meet the presence of companies and significant production chains in terms of number of employees, ability to compete on international markets and links with research centres in the area.

The macro sector of specialisation, focusing on safety and quality of life in the area, deals with the issue of people's well-being in relation to the environment that surrounds them (natural and/or man-made). The focus is also on the relationship between the effects and operating conditions of human activities, whether they be linked to the production of goods and services or of another nature, considering safety as an enabling condition for the improvement of citizens' living conditions.

The actions consequently taken are also fully consistent with the issues connected to the development of the so-called "Smart Communities". Local authorities in collaboration with Regione Liguria have conducted numerous initiatives at national and international level for the development of projects in transport, security, energy efficiency, industry 4.0, industrial automation and bio economy sectors in these areas.

Finally, consistently with the Horizon Europe programme, the National Research Plan and the National Technological Clusters guidelines, the area focuses especially on the following sub-sectors, which reveal significant growth opportunities.

Smart Mobility

The topic of *smart mobility* and, in general, sustainability and efficiency transport systems for goods and people, is one of the key elements in the broader paradigm of Smart Society and includes several interactioning areas:

- people's mobility, both on public and private transport;
- transportation of goods, on urban or territorial basis, extended to logistics nodes such as ports, interports, airports and major road axes;
- development of logistics nodes, a form of integration, resilience, security and ICT for their management;
- planning and management of intermodal transport, through automation of different transport sectors (railway shunting and yards, yard robotics, platform automation, automation of transition gates) and including modelling, simulation, optimization and flows' risk assessment.
- production and management of more efficient and therefore more environmentally compatible means of transport.

Highlights on some fundamental aggregating elements:

- competitiveness and efficiency, the basis of sustainability;
- respect for the environment and quality of life;
- information to the various categories of users;
- transport safety;
- active participation of citizens and stakeholders in the processes.

The main objectives include:

- traffic reduction, with consequent congestion and accidents' decrease in urban centres, reduction of air and noise pollution;
- provision of more effective and efficient transport services, making commuting easier, allowing better management of travelling time and supporting the development of sustainable mobility;
- rationalisation of goods and people's methods of transport, encouraging alternative and intermodal transport solutions, creating opportunities in full compliance with protection of the environmental sustainability of urban centres' regulations and with the economic sustainability of the proposed solutions;
- optimal use of existing infrastructures (major traffic routs and logistics hubs, urban and provincial roads, car parks), equipment (e.g., electric recharging points) and means of transport (freight road haulage, public and private vehicles, bicycles, cars car-sharing/pooling);
- automation of operations related to transport of goods and safety in logistics nodes;
- enhancement of users' mobility autonomy, with consequent provision of inclusive services and barriers reduction;
- increased transport safety.

The areas of intervention, in response to the social challenges associated with the reduction of the environmental impact of transport, safety and the improvement of energy efficiency, are:

- the development and adoption of smart, cooperative and safe transport systems, both in private and public sectors, based on information and services' sharing between users / operators of the supply chain, vehicles and infrastructure;
- the development of technologies for design and production of safe and efficient means of transport (automotive, rail and air transports);
- the development of *eMobility* potential, relating to all vehicles that use electricity as primary source of energy, with the aim of reducing CO2 emissions by improving the efficiency of internal combustion engines and increasing the use of alternative fuels;
- In-vehicle information management systems, travel planning and intermodal transport tools, traffic control systems, ways of optimising driving styles, assistance systems to manage emergencies, alongside fleet management and freight transport applications and Last Mile logistics optimization;
- specific attention to economic, engineering and legal aspects, in support of activities on a metropolitan, regional and macro-regional scale, considering the interactions with the main regional traffic routes and logistic hubs (ports, interports, airports) and, on a larger scale, further interactions with new European roads, rail corridors and maritime routes.

The choice of this sub-sector is due to the importance that Liguria industry assumes in the defined above areas. As significant examples, we can refer to the railway industry (production of vehicles and signalling), Liguria port system, skills on studies and applications of ICT technologies aimed at the development of intelligent transport systems and info mobility systems. In addition, other production chains see the presence of large international players and highly competitive SMEs from a technological point of view.

Energy transition

This new sub-sector replaced the "Smart Environment", transposing and updating the technological trajectories planned for the period 2014-2020. There are new trajectories relating to the challenges that Regione Liguria is facing, in line with the main global trends.

A priority challenge is the transition towards a sustainability model deriving from the adhesion to the de-carbonisation plan for the achievement of the objectives of the European Green Deal, which provides for the EU to be climate neutral by 2050. A priority challenge is certainly the transition to a sustainability model resulting from the accession to the de-carbonisation plan to achieve the objectives of the European Green Deal, which provides for the EU to be climate neutral by 2050.

The sub-sector therefore includes the sectors relating to the various energy sources, their production and use together with the concerning processes and technologies.

The sub-sector is particularly important in Liguria, due to the presence of industrial entities with strong technological capabilities in the energy sector, and of thermoelectric power plants with growing needs to reduce their environmental impact, as well as because of the growing technological capabilities and productive in the sector of intelligent energy distribution (e.g., smart grid).

Hydrogen is a particular focus, being a complementary solution with other technologies for the de-carbonisation of the gas network and the production of electricity, which would maximize the use of renewable sources in combination with high efficiency conversion systems.

In fact, hydrogen can contribute to the reduction of polluting emissions in some sectors such as for example, heavy industry, mobility and manufacturing.

In particular, NRRP encourages a development plan of emerging technologies that support energy transition and conversion and develop a national hydrogen supply chain.

Regione Liguria, promoter of the Agreement for the promotion, diffusion and creation in Liguria transport systems and energy production powered by hydrogen, is strategically in all reference sectors of the hydrogen supply chain, having, on the territory, both important entrepreneurial realities (large companies, SMEs, innovative start-ups) and research institutions.

As for energy transition, energy generation from renewable sources and their related transport, accumulation and conversion are high priority. The hydrogen supply chain, technologies and materials for the development of smart grids and ICT technologies are also high-priority for their efficient management (Smart Grids), as well as energy communities, meant as a set of people who share renewable and clean energy, in a peer-to-peer exchange.

Regarding Smart Grids, there is a solid experience of collaboration between research institutions and companies both in terms of scientific research and for the creation of prototypes (for example, the *Smart Polygeneration Micro grid* project conducted at *Savona Campus*).

Energy communities, one of 2021-2027 priority challenges, represent an innovative model that allows a collective to exercise the right to produce, store, consume, exchange and sell self-produced energy, with the aim of providing environmental, economic and social benefits to one's community.

Renewable Energy Communities (CERs) and collective self-consumption schemes can help mitigate energy poverty by reducing energy costs, thus protecting even the most vulnerable consumers.

Environmental sustainability and circular economy

The growing consumption of natural resources enhanced the interdependence between the economic and environmental systems. The lack of consideration of natural and environmental resources' value in the formation of prices and, therefore, in the determination of choices and behaviours, is one of the main market imperfections, with significant allocative consequences and to the detriment of future generations.

Circular Economy (EC) is central for a sustainable development that combines economic needs with environmental and social needs. It assumes a model that promotes a process of transformation of goods that have reached the end of their life cycle - "closing loops" - based on minimizing waste and reducing the exploitation of virgin raw materials and energy. EC therefore envisages overcoming the limits the linear economy «take – make – use – dispose», through a regenerative approach, in which products are designed to have a long life and to be reused, renewed, regenerated and finally recycled. It promotes resilience increase in of natural resources, its purpose is the reduction and reuse of waste generated by production and consumption activities, which are understood and used as a resource for further production and consumption cycles, thus combining economic growth and environmental protection.

As for sustainable waste management, the European Union is pursuing the objective of improving waste management and transforming it into sustainable material management. Waste prevention is a priority to protect, preserve and improve the quality of the environment, to protect human health, to ensure the efficient and rational use of natural resources, promoting the principles of the circular economy.

Finally, to achieve decarbonisation objectives, the European Union pursues emissions reductions in every sector, from industry and energy to transport and agriculture and particularly in energy-intensive industries, the capture and the use of CO₂ can be a fundamental application for achieving low carbon scenarios.

Similarly, the development of sustainable and efficient production processes by reducing the consumption of resources and the production of waste, the use of renewable raw materials, the replacement of chemical compounds harmful to health and the environment is a priority area.

The production and use of renewable energy to facilitate the energy transition requires new construction materials that ensure an adequate strength in working conditions at variables temperatures, pressures and chemical characteristics. Therefore, it is necessary to develop advanced materials that allow operating optimally in all working conditions and it is also necessary to verify that the materials already in place are adequate to compensate for any reconversions of use for heat transfer fluids that have different characteristics and compositions.

Finally, in accordance with the growing attention at European and national level towards the protection of supply sources and the implementation of strategies aimed at reducing water losses and reusing purified water, trajectories relating to the monitoring and removal of pollutants and the exploitation of sewage sludge are foreseen. These interventions are in line with both the recent update of the EU Drinking Water Directive, which includes new parameters to monitor and stricter limits to respect, and the revision process of the EU Wastewater Directive, which could extend the scope of action to micro pollutants and the recovery of phosphorus from sewage sludge. DGR 60/2021 fully in line with the “Regional Strategy for Sustainable Development” approves the sub-sector and its technological trajectories), with which the Region has set its priorities.

Factories for the future and Industrial Automation

Activities in this area focus on the development of technologies and solutions to support competitiveness and the level of innovation in manufacturing and territorial engineering, especially industrial competitiveness and environmental and economic sustainability (advanced design and production systems, performance improvement, high flexibility, etc.).

In line with national and European roadmaps, the theme of smart factories starts assumes that the development of the manufacturing and engineering system is one of the pillars for supporting the economic growth of the country and the territories, with the aim of qualifying and making the design and production processes, contrasting their delocalisation.

The theme of Smart Factory includes developments in different fields: design and production, control and automation systems, management control, management of resources and maintenance processes, quality control, human-machine interaction, etc.

The above-mentioned areas integrate, with a multidisciplinary approach, different technologies such as ICT, robotics, sensors technology, new materials, etc.

The priority objectives within this sub-sector aim at identifying adequate and innovative development strategies, to obtain components/products/services with high benefit, using process enabling technologies and advanced materials, with special reference to:

- environmental and social sustainability of manufacturing models;
- safety, flexibility and repurposing of the design/production process in relation to products variability and demand conditions;
- methodologies, *software* platforms and *hardware* instrumentation oriented towards optimal planning (taking into account current demand conditions), *real-time* supervisory control based on data acquired in the field and advanced simulation for training and monitoring;
- systems and standards for industrial machinery *servitisation* and *Equipment as a Service*;
- innovative *after sales* services and predictive maintenance systems;
- improvement of technological procedures relating to processing of materials, including those of composite and/or unconventional nature in general, with a view to the optimisation of their use, quality, processing times and cost containment;
- production and design cycles review to improve the use of resources and the reduction of polluting and greenhouse gas emissions, according to the principles of the circular economy.

Furthermore, 3D printing and additive manufacturing play a particularly interesting role, considering that the manufacturing fabric of the region is generally related to small, high-quality production rather than mass production. The sector has a strong growth potential due to the efforts that many companies are concentrating in collaboration with Liguria research system. Fundamental elements of design and manufacturing 4.0 are also the research and development of the materials, the development of innovative design methods and training, monitoring, diagnostic and maintenance tools (Internet of Things, virtual and augmented reality, etc.).

Security and territorial monitoring

The topic of security has a particularly significant value for Liguria. This issue, both in terms of territorial needs (e.g., security of critical infrastructures such as transport and energy, prevention and management of risks associated with natural disasters, environmental monitoring and control), and in relation to the great technological and development capabilities historically expressed by Liguria industrial fabric and research structures. It is quite clear that, in a territory like Liguria, economic growth necessarily depends on the ability to make the territory safe and to act simultaneously on the environmental sustainability factors of production and distribution processes and overall management of the energy sector.

On the one hand, for the safety of our territory it is therefore important to intervene on the reclamation of areas with an elevated level of pollution, through innovative processes and technologies with low environmental impact. That is, through the application of advanced technologies (Artificial Intelligence / Machine Learning), new ways to intervene in the area with robotic tools without the need for human presence in contaminated areas, health/environmental risk analyses.

On the other hand, it is necessary to guarantee the safety of critical infrastructures, as also stated by participation in the "1000 infrastructures to be monitored" programme. The programme is already operative and of absolute value at national and international level, with the important involvement of Liguria research and industrial institutions (IM and PMI) for the monitoring of critical infrastructures (e.g. bridges, tunnels, transport infrastructures).

Furthermore, the integration of computer systems equipped with predictive algorithms (Artificial Intelligence with Machine Learning), fixed sensors and autonomous vehicles for patrolling would allow efficient and effective prevention of accidents and safety problems.

From a technological point of view, we refer in particular to the development of solutions that allow protection and safety of infrastructures, networks, devices, services and systems, the integration and interoperability of systems and services in the management of crises, the protection of privacy. This through the collection and processing of possibly heterogeneous data, the use of communication networks, and the implementation of predictive and decision support models, as well as the use of social networking tools for sharing information.

The technological trajectories and thematic objectives related to the "security" objective are:

- Cybersecurity (in all its forms, both offensive and defensive);
- Technologies and devices for urban security, including intermodal transport of passengers and goods,
- Emergency services for urban and territorial security issues;
- Devices, solutions and sensors for the defence and protection of buildings and critical infrastructures;

- Systems and applications to increase prevention and reaction of the territory to catastrophic events (with reference to natural events) through innovative forecasting, prevention and emergency management solutions.

It is important to note that this area of specialization has an incredibly significant public demand (especially with regard to territorial security and adverse meteorological events prevention) and a solid industrial presence with the ability to develop ICT systems, sensors and devices with application in the areas listed above.

Space Economy

Space Economy is the value chain which, starting from the research, development and creation of enabling space infrastructures, reaches the generation of innovative "enabled" products and services (telecommunications, navigation and positioning services, environmental monitoring, weather forecasting, etc.). It represents one of the most promising development sectors of the world economy in the coming decades.

Italy has a long tradition in space activities: among the first nations in the world to launch and operate satellites in orbit, it is one of the founding members of the European Space Agency, of which it is today the third contributing country.

In the space sector, we are witnessing a very rapid growth of economic activities and, consequently, the creation of numerous opportunities and new business prospects.

With a turnover of around 14 billion euros in 2020, equal to 0.65% of GDP, the Italian Aerospace, Defence and Security (AD&S) sector is seventh in the world and fourth in Europe, where it makes up 15% of the entire market and represents the largest manufacturing sector in Italy in the field of high-tech integrated systems.

The industrial and technological expertise is broad and high level, with territorial excellence that includes fixed and rotary wing aircraft, propulsion systems, software, fuselage, design and assembly of parts, metallurgy, mechanics, electro mechanics, optics, electronics, production and processing of high-performance materials.

The National Aerospace Technology Cluster (CTNA) was founded in 2012.

Italy has also defined a "Space Economy Strategic Plan", which provides for an investment of approximately 4.7 billion euros, of which approximately 50% covered with public resources, both national and regional, in addition to those ordinarily allocated to space politics.

The Plan has five programme guidelines, in line with the initiatives carried out at European level and with the aim of maximizing their impact at national level:

- Satellite Telecommunication (Mirror GovSatCom);
- Support for national participation in GALILEO (Mirror Galileo);
- Galileo PRS infrastructure;
- Support for Copernicus (Mirror Copernicus);
- Space exploration and related technological developments.

Starting from an initial mapping that the Regions themselves helped making it has been possible to outline a framework, divided into components and sub-components potentially complementary to each other, able to represent the territorial distribution of research and production excellence at an international level.

In fact, in Liguria and particularly in Genoa, the Space Economy supply chain can boast excellence and *know-how*, with a huge positive impact potential especially in terms of development of digital

infrastructures, data transmission, infrastructural security, environmental monitoring and of processes digitalisation for an ever-greater effectiveness and efficiency of the logistics chain.

Liguria has important skills, both scientific and industrial, and consequent relevant development opportunities in the following contexts:

- Earth Observation and Geomatics, Space Telecommunications, IoT, AI and Machine Learning, Cybersecurity
- Space robotics, navigation based on integration with LIDAR (Implement Simultaneous Localization and Mapping) and/or SLAM (Simultaneous Localisation and Mapping), human-robot cooperation
- Drones
- Nano structured materials for sensors and devices
- Composite materials for thrusters and airfoils
- Study of the effects of radiation on materials
- Superconductors for magnetic shields, particle detectors and telescopes
- Sensor control systems, data analysis and forecasting for space exploration
- Fluid systems based on natural circulation circuits for energy management in space
- Information and communication technologies as an enabling factor for studies and applications and teaching and learning activities, for example for training processes in the field of aircraft maintenance as well as in human factor assessment processes in the management of complex systems
- Modelling and analysis of spatial Big Data and their metadata; OT-based products and services
- Significant activities on multi-domain enabling macro technologies (AI, Robotics, Big Data, innovative materials, energy)
- Laboratories able to carry out resistance tests and mechanical vibrations on aero-structural components, as well as external and internal acoustic measurements of aircraft
- Study, scientific research and technological development, advanced training in engineering and environmental sciences for the purpose of protecting public health, civil protection and safeguarding ecosystems
- European networking experiences and important links with leading Copernicus organizations. Among others, the Joint Research Centre (JRC) and the Italian National Institute for Environmental Protection and Research (ISPRA).

Safety and Quality of life in the territory - Summary framework

SAFETY AND QUALITY OF LIFE IN THE TERRITORY	
R&D system specialisation level	Very High
Territorial needs	<ul style="list-style-type: none"> • Coping with: energy consumption continuous growth and the consequent environmental impact, climate change in progress, scarcity of natural resources, congestion and overcrowding of urban centres; • Develop a sustainable development strategy from an energy and environmental point of view, but also from a socio-economic one; • Tackle widespread situations of hydrogeological instability and natural disasters.
Strengths and competitiveness of the territory	<ul style="list-style-type: none"> • High use of Local Public Transport (LPT); • Tourist vocation; • Specialization in telecommunications, electronics and scientific research; • Skills diffusion (industrial and research) on the territory; • Consolidated supply chain of large, medium and small companies; • Consistency with the strategic agendas at EU and national level; • High design capacity at national and international level; • Availability of qualified personnel; • Market opportunities linked to the complexity of the territory that has elements of considerable environmental value that require innovative technological solutions for its management and protection.
Impact	<p>The impact of the technological and industrial solutions connected to the area of specialization is extremely broad and affects the following sectors:</p> <ul style="list-style-type: none"> • Education; • Environment and territory protection; • Agriculture; • Construction; • Social and health services; • Hospitality • Shipbuilding and port sector.
Territorial pervasiveness	Whole territory
Sub-sectors	<p>Smart Mobility</p> <p><i>People transport networks and info mobility</i></p> <ul style="list-style-type: none"> • Interaction with the citizen (information diffusion and collection) • Supervision and decision support centres • Planning and management of public and private urban mobility • Management of public and private vehicular fleets • Technologies for transports safety and comfort • Controlled access areas management • <i>eMobility</i> <p><i>Freight transport networks</i></p> <ul style="list-style-type: none"> • Monitoring of transport flows • Supervision centres, operational management of logistics, emergency management • Management, automation, integration, safety, efficiency and development of logistics nodes (ports, airports and interports) • Planning and management of intermodal transport

Evaluation of environmental and economic sustainability of the interventions

- Traffic correlation models - emissions and cost-benefit analysis

Energetic transition

- Energy from renewable and innovative sources, transport, storage, conversion and materials
- Technologies and materials for *Smart Grids*
- Innovative technologies and processes for the creation and development of energy communities
- Processes and technologies functional to the hydrogen supply chain

Environmental sustainability and circular economy

- Technologies and materials for environmental sustainability and historical and cultural heritage preservation
- Integrated water management
- Sustainable waste management
- Design and optimization of new materials (from biological resources or agro-food, industrial and post-consumer waste, metallic materials, semiconductors, quantum materials, metal-ceramic systems, materials for innovative cutting tools, surfactants, nanoparticles, polymer composites and nanocomposites, conductive pastes and inks etc., materials remains for optoelectronics, photonics, energy conversion and storage, catalysis, quantum and space technologies, etc.)
- Process efficiency and environmental sustainability (e.g., CO2 reduction, valorisation of by-products and/or organic waste, etc.)

Factories for the future and Industrial Automation

- Development and integration of innovative devices and sensors with particular reference to the concept of *Industrial Internet of Things* (IoT)
- Innovative systems and applications for Factory 4.0
- Implementation of learning networks and clustering algorithms for diagnostics, maintenance and malfunctions monitoring
- Knowledge technologies and semantic analysis techniques for knowledge bases exploitation aimed at developing platforms related to automation, safety management, accident prevention and sustainable buildings design from environmental impact point of view.
- Industrial automation (control systems, CAD-CAM, hw/sw platforms, robotics, simulators, virtual reality and AI)
- Modelling and representation of knowledge related to the entire production and life cycle and of the products
- Development of innovative services (in the after sales area) and related enabling technologies. Predictive maintenance systems (Life Cycle Cost Analysis and Condition Based Maintenance)
- Virtual, Augmented or mixed Reality technologies and advanced simulation systems for training and monitoring

Security and territory monitoring

- Integrated security systems and supervision centres for critical infrastructures safety (energy, transport, factories, urban areas), goods and people (homeland security, law enforcement)

	<ul style="list-style-type: none"> • Innovative technologies and processes for environmental monitoring with particular attention to weather-hydrogeological risk and climate change • Enabling technologies in the sector (High performance computing, Big Data, IoT/Signal processing, Block chain, 5G/Data transmission, Safety, Security & Cyber, Digital Twin/Simulators, Risk analysis, Early detection, Image processing, Pattern recognition, Innovative ways of using AI and EDGE AI for energy and pollution calculations) • Innovative technologies and processes to support environmental requalification activities • Monitoring and predictive maintenance of critical infrastructures by combining heterogeneous data • PRIVACY & Data Protection <p><i>Space Economy</i></p> <p><i>Upstream and Downstream</i></p> <ul style="list-style-type: none"> • <i>Upstream</i> applications, with particular reference to telecommunications, satellite navigation, Earth observation (EO), automation and robotics • Specific <i>downstream</i> applications for various application areas
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7.3 Healthcare and Life Sciences

This macro area concerns healthcare technologies, products and services including the development and production of drugs, food supplements and in vitro diagnostic devices. It also deals with technologies, equipment and systems to support health and quality of life and to support disabilities and frailties as well as prevention, education, *screening*, diagnosis, therapy, assistance, rehabilitation and the management of health structures and systems.

Compared to the S3 document of September 2019, since the entrepreneurial discovery process, in addition to an updating of the sub-sectors already existing, local players have aimed at greater focus in the field of ICT applied to healthcare. The issue, especially after the Covid 19 pandemic, is also a focal point at a national level (PNRR Mission 6).

In general, this sector is strategic from not only the point of view of the economic and employment potential¹⁷ which is also high, but above all, for its social value; indeed, the offer of quality, high-tech products and services has immediate repercussions on the health and well-being of citizens. The sector is constantly evolving, but it is possible to identify two peculiar aspects:

- The definition of the boundaries between research and application is scarce, with remarkably close relationships between the clinical world, research centres, companies and *end users*. The presence of numerous intermediate players, such as spin-offs and start-ups in the making, means that the creation of innovation takes place with mutual contamination and research and business are interdependent and mutually reinforcing.
- It is a point of arrival for technologies coming from various fields, well beyond the strictly biomedical, pharmaceutical and biotechnological ones. Consider, for example, the growing importance of robotics, mechatronics, telematics, artificial intelligence and materials science in healthcare.

Regione Liguria has identified in this area of specialization the sub-sectors with the greatest potential for generating innovation and economic development, considering the demographic and social peculiarities of Liguria and the needs of the regional healthcare and social services system including:

- An aging and increasingly fragile population.

The trend towards an increase in the elderly population is a global issue, but it is particularly prominent in Italy and specifically in Liguria. The aging of the population has led to an increase in the incidence of degenerative joint diseases, tumors, heart diseases, diabetes and neurological diseases often of degenerative nature. If the challenge is maximising well-being and quality of life of as many people as possible and for as long as possible, it is necessary to develop innovative pathways that will greatly benefit from technologies. Crucial aspects are prevention through the promotion of "healthy" lifestyles; screening and early diagnosis of situations of fragility and pathologies at risk of becoming chronic; managing chronic and degenerative pathologies - including rehabilitation and assistance - based on centrality of the person and on support and care continuity (from hospital to home). Situations of fragility do not only concern the elderly, but various context and seem to be an increasingly widespread phenomenon in our society.

There is an increase in children with development disorders and with special educational needs, for them it also arises the problem of transition to adulthood.

¹⁷ Liguria public expenses on healthcare in 2019 amounted to 3,207.2 million euros, while that for social protection amounted to 430.1 million euros (source: Istat - Territorial economic accounts, chained values with reference year 2015). The benefit produced by "Health and social assistance" economic sector was equal, in 2019, to 2,577 million euros (source: Istat - Territorial Economic Accounts, linked values with reference year 2015).

For disabled people, there is the issue of assistance to the individuals' path towards autonomy and independence in daily life.

- Towards a predictive, preventive, personalized and participatory medicine (4P medicine).

Demographic changes and technological developments are producing a change in medicine compared to the traditional model based on symptomatic treatment of acute illnesses.

Elements of the new paradigm include:

Prediction (identification of individual risks of developing certain diseases based on genetic profiles and other personal information);

Prevention (methods and treatments to avoid, reduce and monitor the risk of developing certain diseases);

Personalization, i.e., clinical interventions based on the unique genetic, medical and environmental characteristics of each individual and on the genomic profile of the expression of his pathologies.

The wide availability of information on diagnoses and treatments has shifted lots of responsibility towards the patient in determining therapeutic pathways, thus the participation of each person in the management of their own health is increasingly important. These changes, including cultural ones, urge health systems to go towards the personalization of therapeutic or rehabilitative interventions, both in the definition of treatment plans and in the methods of administration. The phenomena described above are synthesized with the use of the term 'precision medicine', the preconditions of which are, on the one hand, a state-of-the-art diagnostic/therapeutic offer and, on the other, health management based on the processing and use of data organised according to the elderly and fragile patient.

The analysis of scenarios, skills and social challenges suggests some peculiarities of Liguria, such as:

- (i) its demographic structure, which makes it one of the oldest regions in Europe;
- (ii) the widespread heritage of skills and abilities in the biomedical, automation and information and communication technologies sectors, characterised by an articulated production system and by a significant presence of high-level research centres;
- (iii) the availability of a human capital of potential "innovators"- master's graduates and above all PhDs related to biomedical technologies (bioengineering, biotechnologies), information and communication technologies.

These characteristics define Liguria as a region with a natural vocation as a "laboratory" for the development and experimentation of technological, social, health and training innovations linked to the aging of population. Such innovations could create opportunities for growth and wealth, thus constituting one of the pillars of the so-called silver economy.

Technologies for regenerative, predictive and personalized medicine

In Liguria there is a strong presence of Research Institutions with activities in the sectors of immunology, regenerative medicine, molecular biology, pharmaceutical intermediates, molecular biology diagnostic kits and tissue engineering and *imaging*. A synergy which contributes to the generation of a dynamic context in which the University of Genoa, IIT, SMEs and large companies develop technologies (e.g. for imaging and diagnostic platforms, robotics, rehabilitation, assistance and education) for regenerative, predictive and personalized medicine.

The dynamism of this context sees the actors' involvement in national and European projects in close collaboration with A. LI.SA (Azienda Ligure Sanitaria) and with regional *governance*.

Specific areas of activity include:

- Regenerative medicine: replacement or regeneration of tissues or entire organs, through engineered cellular systems or by activating endogenous regeneration mechanisms;
- Personalized and predictive medicine, with particular reference to rare diseases;
- Testing of new pharmacological therapies, new targets, alternative *drug delivery* and pharmacological *repurposing*, with particular reference to orphan diseases. One of the main advantages of *repurposing* is the reduction of the time to bring a drug to the patient and of the costs of testing and development. *Repurposing* already studied important parameters such as the pharmacokinetics, pharmacodynamics and toxicity profile of the new molecule so it is possible to skip the initial research phases and go straight to clinical efficacy studies. This therefore allows to greatly reduce the costs of experimentation and development;
- industrial biotechnology: production of cells and/or microorganisms for personalized medicine, biomaterials or regenerative medicine;
- AI applications in medical field and *digital twin* technologies development. Systems Medicine-type approaches, which apply computational techniques to multi-modal data, allow a holistic understanding of pathologies and therefore greater efficacy in diagnostic, prognostic and therapeutic terms. In particular, the development of bioinformatics techniques aims to:
 - Use in a short time and at reduced costs large amounts of information about the individual person and the individual pathology, with goals of prediction and personalized care;
 - Study comorbidity, fundamental aspect for the formulation of therapeutic solutions based on the integration of heterogeneous data, with objectives of translational and clinical research and for the study of human-machine interaction in medicine. The availability of structured biomedical data databases and computational tools for their analysis and interpretation will be fundamental for the productive fabric of the territory. In fact, it will boost competitive design, collaboration in the testing of innovative solutions and the realization of training courses designed ad hoc.

Diagnostic platforms and technologies in omics

Developments relating diagnostic platforms are connected to heterogeneous external factors, which influence their innovation itself, responding to the logic of industrial impact and opportunity. Increasing life expectancy means increasing the cost of public health-funded care, as older people use more health services than the average. Cost growth is changing the design, production and procurement strategies of diagnostic equipment, increasingly automated and with an optimized cost-benefit ratio and is pushing healthcare service providers towards increasingly integrated diagnostic and therapy guidance devices and minimally invasive.

In Liguria there are large and some medium-sized companies that deal, directly or through the provision of services, with the development of diagnostic, support and assistance platforms used worldwide and in most of the ASL¹⁸, IRCCS¹⁹ and AOU²⁰ of Liguria.

¹⁸ ASL Azienda Sanitaria Locale (Local health board)

¹⁹ IRCCS Istituto di Ricovero e Cura a Carattere Scientifico (Institute for Treatment and Research)

²⁰ AOU Azienda Ospedaliera Universitaria (University Hospital)

Finally, to complete the whole scenario, also note the presence of some micro and small enterprises active in:

- development of wearable systems (certified for medical use and for self-monitoring)
- development of software for medical devices,
- design and construction of systems for the detection, processing and transmission of data from sensors
- development of information systems and applications in hospitals and territorial settings for the management of clinical data

The main areas of activity in the context of diagnostic platforms and technologies are:

- Diagnostic imaging systems: The adoption of imaging equipment characterized by a rapid deployment capacity and for multiple clinical procedures, which integrate structural and functional information, is increasingly a focal point for many healthcare professionals. To meet the needs of healthcare systems, manufacturers will therefore have to develop a portfolio of products and solutions that are able to facilitate their use as much as possible, significantly increasing process efficiency and maximizing return on investment;
- *Smart devices and sensors*. The evolution of the market and healthcare organization requires the development of new systems and accessories and innovative production and logistics processes in the light of a sustainable approach, with a view to circular economy and evolution of the certification processes. In the forthcoming years, a great development of early diagnosis programmes with an integrated approach is predictable, which will combine medical imaging, molecular health and genomic data. Non-invasive methods of therapy administration and even remote monitoring of its effectiveness will increasingly extend. The development of minimally invasive and non-invasive smart devices and sensors will be particularly important, allowing, in real time, planning, orientation, decision support and treatment monitoring with better clinical efficacy and results management. As for interventional radiology, mention should be made of the systems aimed at eco-guided thermal ablation and at the improvement in administering radiotherapy methods in cancer patients;
- Data based diagnostic process management models: diagnostic imaging platforms and non-invasive diagnostic methods provide the doctor with a large amount of data that can also be integrated by traditional sources, such as reports or clinical reports, or innovative ones, such as data collected from wearable devices. The wide information availability that may be related to each other and the development of advanced predictive and prescriptive analysis methods lay the foundations for speeding up the diagnostic process and reducing misinterpretations, minimizing costs. Therefore, it will be necessary to promote and ensure a real semantic interoperability of all diagnostic data relating to the same patient and certain classes of diseases. The possibility of storing and managing objective data also allows extending the time horizon to the entire care continuum, from the stages of prevention until after treatment. It should be included in this context the possibility of remote diagnostics, via devices at the patient's home or wearables, which can allow continuous remote monitoring of different clinical parameters that can be integrated with already available data, for the early identification of pathological conditions changes or warning signs of the onset of acute pathologies. The availability of extensive databases where medical images and other patient information gather allows the development of health management policies based on objective and continuously updated population data.

Based on these analyses, it will be possible also to manage effective screening programs and improve disease susceptibility assessment, surveillance and awareness.

Finally, the development of new diagnostic and analytical devices will require the development of new technologies and appropriate materials. For example, 2D/3D models for the study of diseases including new humanized chimeric models which, through in vitro production of miniature versions of organs and thanks to advances in stem cell technology and bioengineering, currently allow scientists to artificially evolve a mass of cells into organoids with organ-like properties. Two-dimensional cell cultures are now used in a large number of experimental research for physiology and tissue development studies, as well as for testing for certain genetic diseases and to produce pharmacologically active substances. Following the observation that cells do not behave in 2D cultures as they do in vivo, 3D cultures of organoids have emerged as promising model systems for studying tissue development and generating new therapies.

Organoids represent cells grown in specific three-dimensional (3D) environments, creating mini, simplified organs that retain some physiological function. They derive from one or a few cells, a tissue, embryonic stem cells or induced pluripotent stem cells, which can self-organize into three-dimensional cultures. These are promising model systems for the study of tissue development and the generation of new therapies. Models have now been grown for many organs: brain, liver, kidney, breast, retina and organs of the gastrointestinal tract. Their potential use ranges from infection and toxicity screening models, to testing for pharmaceutical molecules, personalised medicine, and regenerative/organ replacement medicine.

Robotics and innovative technologies applied to rehabilitation, care, integration and education

This area of activity is most immediately associated with the support of aging and fragility. Technologies such as robotics and virtual reality are potentially capable of making neuro rehabilitation accessible to more people and for longer. In addition to having an immediately perceptible application potential, the market for rehabilitative robotics is proving to be booming. In the next few years, the development of new technological solutions (wearable robotics or soft robotics) and new application areas and more compact and cost-effective systems, suitable for tele-rehabilitation and at home rehabilitation, is expected. Modulation of the activity of portions of the nervous system or muscle by electrical stimulation is another promising approach to facilitate the recovery of functions. Electrical stimulation as a substitute for natural nerve activity is now widely used (neuromuscular stimulation, cochlear implants, deep brain stimulation, and transcranial electrical stimulation). Driven by these successes and the progress of miniaturization, interest has recently widened to include "electroceuticals" (Neurostimulation), i.e. devices that send electrical impulses to peripheral nerves to simulate or alter the impulses received by an organ from the central nervous system and therefore promote or control its function even in the absence of physiological stimulation. The treatment of pain and neuromuscular disorders are the most developed areas of application today, but the possibilities are wide.

Some specific areas have been identified:

- Technological aids to support the independence of people with sensory, motor and cognitive disabilities (prosthesis, ambient-assisted living): the performance (or non-performance) of the activities of daily living (Activities of Daily Living, ADL) is an index of the level of independence of a "fragile" person and/or with specific sensory, motor and cognitive disabilities, but geriatric visits for ability assessment are not suitable for appreciating any decline over time. Monitoring must extend to everyday life, to be able to highlight trends and situations that would be impossible to evaluate through short visits.

Thanks to the synergy of Internet of Things (iot), Artificial Intelligence, Big Data and Cloud Computing it is now possible to conceive technological aids able to obtain such information (both through distributed and wearable sensors) in an almost continuous and pervasive way, analyse them both in real time and in the medium/long term, and to extract and analyse them.

Promising directions concern:

- (i) Wearable sensors and electronics related technological challenges, embedded systems, on-board information processing;
- (ii) Sensors deployed in the environment, possibly integrated with pre-existing domotic systems, and challenges related to easy installation, configuration, maintenance, reliability;
- (iii) Personal health systems based on mobile (m-health), wearable and implanted devices for life-logging based on activity recognition algorithms able to detect whether or not ADLs of medical interest are being used and possibly suggesting to the assisted person healthy lifestyles and able to mitigate the effects of sensory, cognitive and motor decline, especially in the case of chronic diseases.

In these areas, there are start-ups and micro-enterprises in Liguria as well as advanced clinical trials (Galliera Hospital). Prosthetics (sensory and motor) are another category of assistive technologies. In Liguria, there are important activities in this area, both from clinical-assistance and from research and development of technologies, devices and solutions point of view. Some small companies develop and commercialise highly innovative devices (hearing prostheses and aids for the visually impaired). In addition, research organisations develop prostheses for amputees or aids for people with reduced mobility, which are characterised by low cost and high usability. Technological developments and the increase of people with disabilities suggest a great development of these activities in the coming years.

- Technologies and systems for social, educational and work integration and for accessible tourism of people with special needs: it is a rapidly evolving research and application sector of interdisciplinary nature to develop models of inclusive situations with the support of digital technologies. These models can also apply to different and more general situations. Technology plays a significant role as for solutions and perspectives: the study of training opportunities offered by technological developments (*e-learning platforms, social media, cloud computing, mobile, tangible systems, etc.*); the analysis of innovative learning methods (for example, *game based learning, mobile learning, e-learning, etc.*); the study of needs and problems in the various formal and non-formal educational contexts;
- Technologies and systems for continuous training, advanced simulation and *patient empowerment*: continuous and initial training can now make use of technologically advanced systems and tools that allow a better management of resources, the possibility of targeted and specific training and advanced solutions from a technological and haptic point of view. For example, in addition to the possibility of creating innovative e-learning courses, training based on highly technological "dummies" and use of controlled or semi-computerized precision instrumentation offering opportunities for innovation both in terms of advanced training and in terms of technological development. In these areas in Liguria there are international-level research activities, innovative start-ups that produce specific devices (robots, wearable systems, and prostheses), companies that market them and companies that supply enabling technologies (robotics, virtual reality, *and serious games*). Target markets are individual hospitals, public health system in general, foundations, non-profit organizations and associations devoted to special

needs users. For these activities, it is strategic to strengthen collaborations with clinical structures and with user groups, both for the evaluation of usability in the pre-commercial phase, for clinical validation, and for the economic evaluation (health technology assessment) of the solutions developed.

Technologies and methods for the use and enhancement of Big Data in healthcare

Over the last decade, technological development has made it possible to collect ever-increasing volumes of data of various kinds, generated at ever-greater speed and digitally storable at low cost (Big Data). The possibility of having access, analysing and interpreting these data (medical and other) is a strategic resource for the territory. The proper management of this resource can become a formidable tool for the development and transfer of new technology with significant economic consequences.

The relevant areas include:

- Acquisition and management of medical data: infrastructures development for the acquisition and federated management of massive quantities of data. In this context, the use of qualified cloud platforms will be relevant to minimize the economic impact of investments, ensuring flexibility and scalability;
- Analysis and interpretation of biomedical data: development of tools and technologies that allow data to be analysed and interpreted, to use them to automate processes and make decisions. In particular, in Healthcare and Life Sciences, the goal is to improve clinical and research pathways through an approach increasingly linked to evidence;
- IT security and medical information privacy: definition of a *framework* that allows research and development to use the large amount of data collected, but at the same time guarantees patient privacy. To this end, investments will be required to study, implement and validate *privacy-preserving data mining* techniques;
- Development and implementation of disease registries, creation of epidemiological and management models: disease registries are scientific research tools for the development of epidemiological and clinical studies and health programming, which allow the collection of elements useful for the planning of adequate health services.

It is in fact necessary to implement actions on specific thematic areas such as networks, monitoring systems, unification and standardisation of disease coding, related diagnostic-therapeutic care pathways (DTCP), involvement of patient associations and their families, research, training, information and, finally, prevention (primary and secondary).

- New models of organisation, management, development and exploitation (transfer) of research from the territory and territory: in line with the National Health Research Programme (PNRS 2020-2022), a high-level biomedical/health research activity, as well as increasing scientific knowledge, is a fundamental factor of cultural and scientific growth for the environment in which it develops. Health research in NHS is an investment for the future of the structures and their environment and is the main opportunity to be included in international research networks and circuits, increasingly necessary to develop high-level research. Furthermore, it is necessary to create and spread adequate information and cultural promotion of innovation with a real health impact in the population.

In Liguria there are research institutions of international prestige, small companies that develop artificial intelligence solutions, machine learning and predictive analysis in the medical field and large companies

operating on the international market with many years of experience in the marketing of clinical and diagnostic flows in compliance with norms and standards for the medical device sector.

Healthcare information systems and infrastructures

The ever-increasing application of ICT in healthcare processes has led to a significant increase in the development of information systems for the management of healthcare data in various contexts, such as medical and hospital records, healthcare dossiers, healthcare and personal files. In recent years, there has been an increasing interest in information systems for the creation of a unified Healthcare Information System at national level, in line with the international commitments undertaken by Italy. Current health information systems are partial and not interconnected with each other; this implies the definition of interoperability architectures for the requalification of Healthcare Information Systems to eliminate/reduce data fragmentation and duplication.

The exponential increase in the use of information systems and connected devices (Internet of Medical Things - IoMT) is generating a data security problem. In fact, policies generally used for so-called "standard office" environments are not always applicable to instrumentation and medical applications. In addition, healthcare institutions are subject to strict regulations, which require high standards and levels of safety and compliance. It is therefore necessary to ensure an adequate level of security of the networks and information systems of healthcare facilities, in line with the indications provided by the European Network and Information Security Agency (ENISA).

In particular, the primary areas of intervention are:

- Architectures, models and applications for process and data interoperability: current health information systems are partial and not interconnected with each other. Therefore, the definition of interoperability architectures for the requalification of Healthcare Information Systems is fundamental to eliminate or at least reduce data fragmentation and duplication. Supporting and promoting the adoption of data coding standards will lay the foundations for their aggregation and will allow healthy competition on the market by companies, eliminating, where possible, barriers and risk of lock-in for the health institutions. Moreover, it would lead to the creation of a unified national Health Information System, in line with the international commitments undertaken by Italy. For example, it could be defined a roadmap, agreed between the actors involved, to define levels of integration and adoption of gradually increasing standards, starting from the solution of interoperability problems between clinical and healthcare services and finally reaching a multidimensional integration with purposes purely aimed at biomedical and biotechnological research (integration between clinical and genomic data);
- Cybersecurity development of remotely accessible technologically advanced medical devices (implantable, wearable, diagnostic and therapy) and IT systems (for non-MD functionalities): Healthcare is one of the most critical sectors in terms of cybersecurity. Network and information system security can be crucial to ensure continuity of services in digital health, especially in crises such as the recent pandemic. The need to ensure an adequate level of security in healthcare facilities, both in terms of network and information system security, and in terms of patient privacy and data protection, becomes even more urgent considering the exponential increase of the use of information systems and connected devices in healthcare and hospital settings. The policies generally used for so-called *standard office* environments are not always applicable to medical instruments and applications. Furthermore, healthcare institutions are subject to strict regulations that require high and compliant levels of safety. It is therefore necessary to focus on the cybersecurity of medical devices, identifying key requirements and safeguards activated by

the regulatory framework, to ensure an adequate level of security of the networks and information systems of healthcare facilities even in a context of exponential increase in the use of information systems and of connected devices (Internet of Medical Things – IoMT). In addition, it is essential to ensure the protection of patient privacy and data, especially for so-called smart hospitals.

Healthcare and Life Sciences – Synthesis Framework

HEALTHCARE AND LIFE SCIENCES	
R&D system specialisation level	High
Local needs	<ul style="list-style-type: none"> • New needs for social and health care linked to the demographic structure of the population; • Paradigm shift, from a medicine based on diagnosis and treatments to the Medicine of the 4Ps: Predictive, Preventive, Personalized and Participatory; • Rethinking and reorganizing the health system according to the conformation of Liguria territory; • Need to develop solid, interoperable and secure IT infrastructures for the management of increasingly numerous and complex healthcare data and processes.
Strengths and competitiveness of the territory	<ul style="list-style-type: none"> • Excellence network with consolidated technical-scientific and industrial chain relationships and collaborations between the business system and the world of public research; • Good competitive positioning at national and international level of research activities; • High design capacity at national and international level; • Presence of spin-offs and companies of excellence; • Specialisation in the production of electro medical and electrotherapeutic equipment, software systems for managing healthcare systems; drugs, reagents, pharmaceutical intermediates, food supplements and nutraceuticals; scientific research in all biomedical technologies areas; • Consistency with strategic agendas at EU and national level; • Availability of qualified personnel.
Impact	<p>The impact of technological and industrial solutions related to the Specialization Area is extremely broad and involves the following sectors:</p> <ul style="list-style-type: none"> • Environment; • Biosensors; • <i>Green Chemistry</i>; • Electronics and IT; • Mechanics (instrumental and precision); • Domotics
Territorial pervasiveness	Whole region
Sub-sectors	<i>Technologies for regenerative, predictive and personalized medicine</i>

- Regenerative medicine and in vitro models for personalized and predictive medicine, with a focus to personalized medicine for rare diseases
- Industrial biotechnology
- Functional tests and trials to support the identification of new pharmacological therapies, new targets, alternative "drug delivery" and pharmacological repurposing with particular reference to orphan diseases
- AI applications in health and Digital Twin development

Diagnostic platforms and technologies in omics

- Diagnostic imaging systems
- Data-driven diagnostic process management models
- Smart devices and sensors
- Technologies and materials for diagnostic and analytical devices and 2D/3D models for diseases study, including new humanized chimeric models

Robotics and innovative technologies applied to rehabilitation, care, integration and education

- Technological aids to support the independence of people with sensory, motor and cognitive disabilities
- Technologies and systems for the social, educational, occupational integration and accessible tourism of people with special needs
- Technologies and systems for continuous training, for advanced simulation and *patient empowerment*

Technologies and methods for the use and enhancement of Big Data in healthcare

- Acquisition and management of substantial amounts of medical data
- Analysis and interpretation of biomedical data
- IT security and health information privacy
- Development and implementation of disease registries, creation of epidemiological and management models
- New models of organisation, management, development and valorisation (transfer) of research from and within the territory

Healthcare information systems and infrastructures

- Unified computational *framework* to harmonize architectures, models and applications for the interoperability of usability-oriented processes and data, architectures, models and applications for the interoperability of processes and data
- *Cybersecurity* development of remotely accessible technologically advanced medical devices (implantable, wearable, diagnostic and therapy) and IT systems (for non-MD functionalities)

8 REGIONE LIGURIA STRATEGY 2021-2027

8.1 Vision and objectives of S3 regional strategy

The Regional Smart Specialisation Strategy for the 2021-2027 programming period has as its general objective to:

Reinforce research, technological development and innovation activities by exploiting both current and emerging strengths, ensuring coordination and concentration of initiatives and various funding sources

The strengthening of the production system closely connects to processes aimed at:

1. encouraging and supporting innovation within companies, also promoting cooperation models between companies and research subjects;
2. encouraging and supporting the digital transition, which in the perspective of the S3 acts as a guide for products technological innovation and for new production processes;
3. favouring and supporting ecological transition, both to contribute to the sustainability and de-carbonization objectives established by regional policies (primarily the Regional Strategy for Sustainable Development), and to seize the opportunities that these processes entail in terms of technological responses and competitive advantage;
4. Strengthening the skills system to guide these transition processes. In fact, a rapid alignment of the social and employment base with respect to the new global challenges is essential.

It is important to consider that the various implementation tools will be coordinated and integrated always taking into account that S3 originates as a strategy that:

- It is coherent with the priorities at EU, national and regional level
- Relates to a dynamic system focused on research, innovation, development of new enterprises and on small enterprises innovation;
- Has not just a territorial dimension, but moves towards internationalisation, investments and talents attraction and above all towards European interregional cooperation.

In this regard, the **specific objectives** are the following:

Encourage innovation promotion and research support, including cooperation models between companies and research actors

In light of the positive experiences initiated in the 2014-2020 programming, new actions will aim at:

- enhancing innovation processes within companies;
- supporting the creation of new innovative businesses;
- consolidating cooperation between universities and regional research centres with the business system, also with a view to technology transfer promotion.

Strengthen the digitalisation processes in PA and in Liguria micro, small and medium-sized enterprises, especially in the light of the new needs and challenges since the pandemic.

Consistently with the programming 2014-2020 and following Liguria Strategic Program Digital 2019-2021 guidelines, actions will aim at:

- meeting the needs for new digital services, which occurred especially during the pandemic period;
- reducing costs and increasing the quality of digital services both for citizens and businesses;
- strengthening PA modernisation processes through digitalisation.

Promote renewable energy-oriented processes and resource-oriented circular economy models

In accordance with the 2030 Agenda, the Green Deal, the Regional Sustainable Development Strategy, and the Regional Environmental Energy Plan (PEARL) action will aim at:

- Enhancing, from an energy point of view, the efficiency of the manufacturing sector and public energy-intensive building assets
- Encouraging the use of renewable energies, both in the private and public sectors through the promotion of innovative forms such as energy communities
- Encouraging the implementation of circular economy models aimed at strengthening the production system competitiveness with a view to efficient use of resources.

Reduce the growing mismatch between skills supply and skills demand: start training courses to meet the needs of skills of the labour market, with particular focus on the 21-27 challenges and on S3 priority areas

The adaptation and qualitative improvement of the «human capital» is a fundamental stage in the innovation process and is essential to respond to the growing demand for specialist skills, especially green and digital ones. To this end, the following courses will be encouraged:

- *Capacity building* for small and medium enterprises;
- High-tech training in MSMEs with a particular focus on development of skills for industrial transition, smart specialisation and entrepreneurship;
- Higher education to promote the connection among tertiary education, production system and research institutes.

Promote interregional/international cooperation projects, with the aim of fostering the exchange of new knowledge, developing synergies and joint activities in S3 priority areas

Compared to 2014-2020, 2021-2027 S3 will focus more on the "extraterritorial" dimension to promote regional specialisations outside Liguria territory, to multiply the opportunities for enterprises synergy and to diversify the tools for S3 implementation.

For this purpose, actions will aim at:

- CTE Programmes participation within the three S3 areas of specialization
- Intensifying the presence of Regione Liguria in the thematic platforms that are fundamental for the definition and participation in the new European investment programmes for the period 2021-2027.

Ensure an effective governance, monitoring and evaluation system able to measure the performance compared to the strategy objectives

The pursuit of that objective entails:

- a strengthening of *governance* tools in order to have more effective and inclusive relations between the actors in the regional research system;
- an increased and widespread involvement of the entire regional community in the process of defining and updating the Strategy enhancing the listening of the territory or the so-called "Quadrupla Elica" – i.e. quadruple helix - (institutions, business, research and civil society) ;
- a new monitoring and evaluation process, conducted continuously and periodically so that both the Strategy and its implementation will have constant verification process to identify any critical issues or need for updating and make the consequent corrections, with a view to continuous improvement.

8.2 The implementation tools of the regional S3

In order to implement the S3 for the 2021-2027 programming period, Regione Liguria will carry out actions based on different funds that, in a synergistic way, will contribute to the objective's achievement. All this in line with the objectives set, the global challenges and the positive experiences of the 2014-2020 programming period as well as with what emerged during the public consultation phase.

Notably, the main measures will relate to ERDF and ESF funds and to planning in a European Territorial Cooperation (ETC) context, mostly to create new opportunities for the external opening of the territory. Greater collaboration between the Regions is in fact essential to give substance to the process of strengthening S3 based on the enhancement of the complementarities of the technological development trajectories existing at the level of the individual territories. Currently, thanks to a significant European project, Regione Liguria is able to encourage and support the presence of different regional stakeholders in European and international networks.

Regione Liguria has been developing international (and above all European) cooperation activities for years, particularly focused on the three strategic areas identified in S3, also by active participation in networks and in initiatives supporting R&I, with the main objective of supporting the internationalisation of companies and the attractiveness of the area in Liguria system.

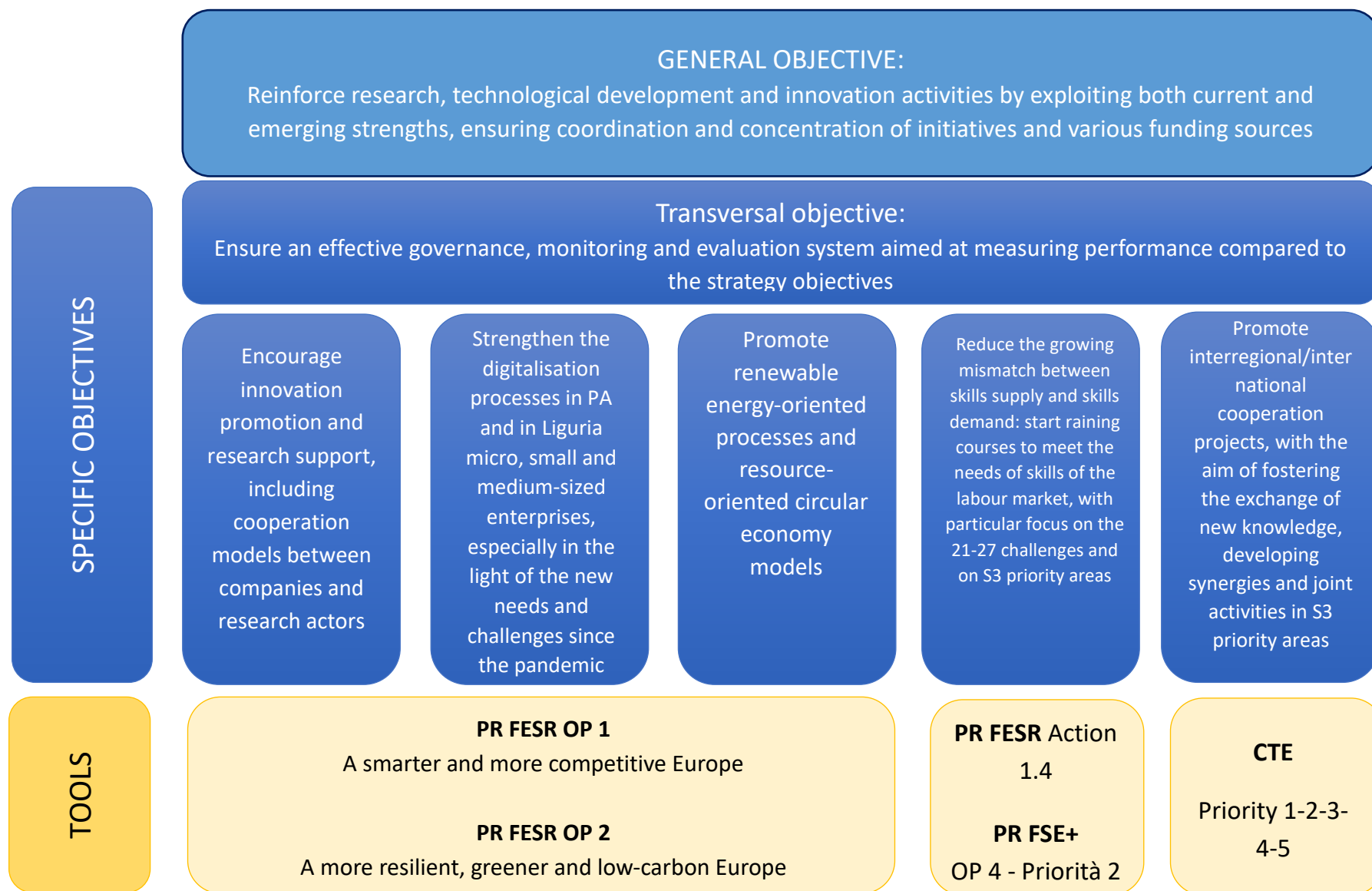
A strong contribution to the implementation of the regional S3 will come, transversally, from the projects under the National Recovery and Resilience Plan (PNRR). An example is the ROBOTICS AND AI FOR SOCIO-ECONOMIC EMPOWERMENT (RAISE) project, which aims to support the development of an innovation ecosystem based on the scientific and technological domains of AI and Robotics. The ecosystem enhances and develops regional vocations and is fully consistent with the three macro-areas identified in this document. We should strongly emphasize the importance of research and development in the field of robotic technologies and artificial intelligence in all three areas.

RAISE, starting from a specific scientific and technological focus that sees Liguria at a high international level, intercepts the technological trajectories identified in S3. Within the specialization area, "Technologies of the Sea" the following S3 themes are priority: logistics, security and automation in port areas and protection and enhancement of the coastal marine environment. Concerning the area of specialization "Safety and quality of life in the territory", the priority themes S3 included in the proposal RAISE are related to the energy transition, security and territorial monitoring.

Finally, the priority themes in specialisation "Health and Life Sciences" are diagnostic platforms, technologies for rehabilitation, healthcare, integration and education.

Below, by way of non-exhaustive example, we highlight the main tools for the pursuit of the objectives.

It is implied that, since S3 is a dynamic document that meets and monitors territorial emerging needs, Regione Liguria can and must modify or redefine the implementation tools over the course of the seven-year period. This in line with any evidence that could emerge from the territory during the entrepreneurial discovery process and/or from results of the monitoring and evaluation process that require corrective actions.



9 GOVERNANCE MONITORING AND EVALUATION

9.1 Governance in S3 2021-2027

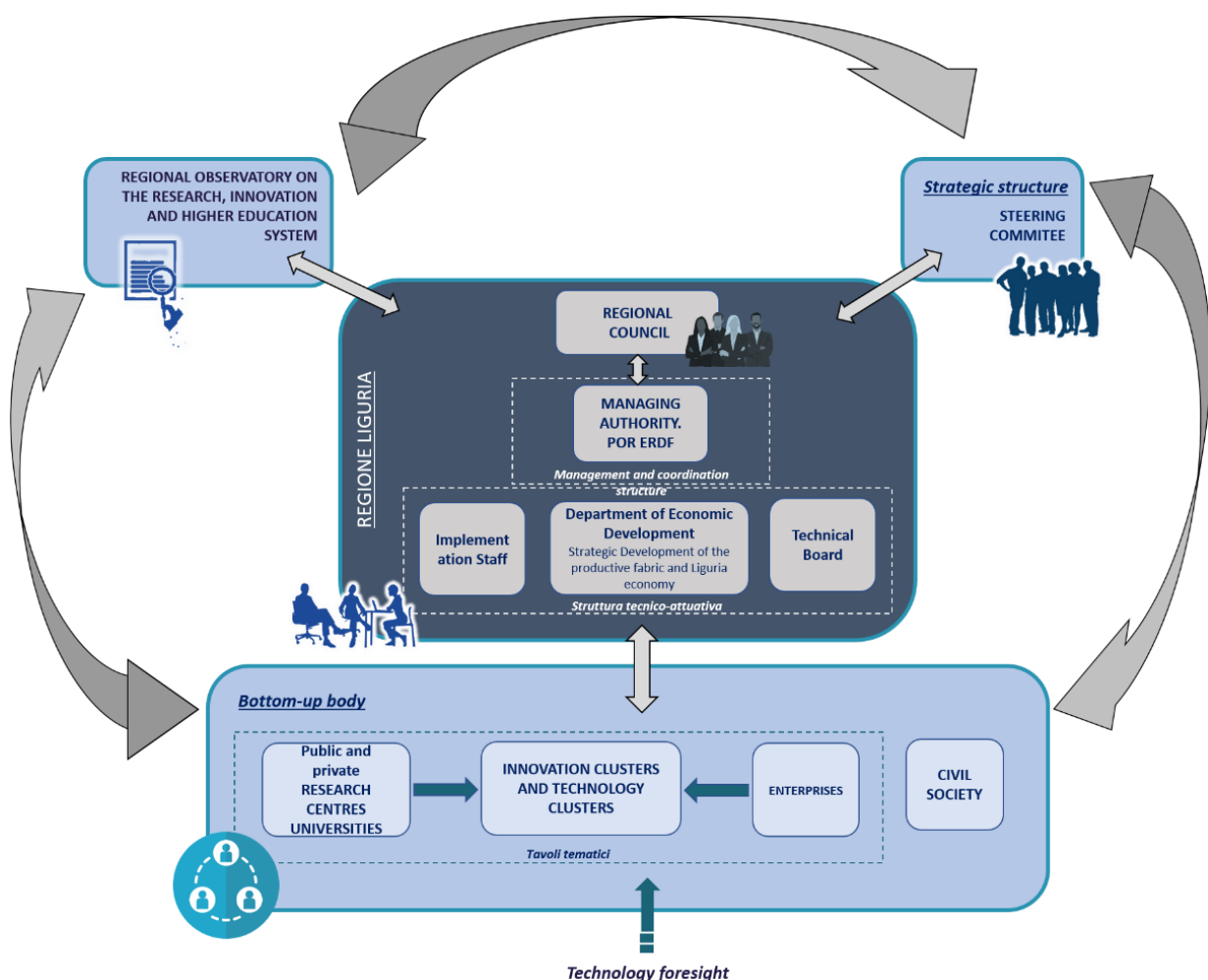
S3 2021-2027 inherits a solid governance system, characterised by well-organized bottom-up processes that ensured a constant dialogue with all major stakeholders (research institutions, business and other stakeholders) considering them true components of the implementation process of S3.

Compared to the previous experience, 2014-2020, Regione Liguria governance structure has improved and better defined the roles and responsibilities of all the participants, particularly regional bodies.

In particular, notwithstanding the 2014-2020 governance approach, we proceeded:

- to involve civil society in the process: in fact, the participation of those who benefit from research and innovation, groups that represent the demand needs, consumers and non-profit organizations representing citizens and workers is indeed important;
- to assign clear roles, functions and responsibilities to the various governance subjects, also implementing new coordination and information sharing mechanisms, in order to make the process increasingly efficient and effective.

The regional system actors interact according to the scheme in the following figure:



Details about roles, functions, responsibilities and interaction of the various subjects follow below:

POLITICAL STRUCTURE

Regional Board

It is the political body, which approves the Smart Specialization Strategy document and its modifications and implementations.

MANAGEMENT AND COORDINATION STRUCTURE

Department of Economic Development - ERDF Managing Authority

It is responsible for S3 and represents the reference figure for the implementation of the strategy both within the Region and towards external authorities/structures (national and European tables). Interfaces with the administration political body to agree on the strategic orientation to follow during the implementation phase, also in line with the programmatic framework in terms of R&I. It promotes coordination actions with other Regions. Ensures the constant strategy updating based on the reference context, monitoring data and verifies the effectiveness of its implementation. Coordinates the structures involved in the implementation of the S3 and plans and schedules work.

In detail, its purposes are the following:

- Definition of S3 vision, priorities, objectives, interregional and international collaboration;
- Definition of financial sources and policy mix;
- Definition of a governance organization chart;
- Definition of the Strategy approval process;
- Definition of complementarity and synergies with other national, regional and EU strategies and tools;
- Development of tools under the ERDF/ESF/EAFRD;
- Transformation of the entrepreneurial discovery process (EDP) outputs into potential tenders also through the assessment of the regulatory framework of different financial sources (eg ESI regulations, state aid, etc.);
- Development and timing of calls for ERDF/ESF, EAFRD;
- Analysis of calls' coherence with S3 of OP ERDF/ESF, EAFRD;
- S3 communication (internal to the public administration and to external stakeholders);
- Responsible for the monitoring and evaluation process;
- Internal and external communication of monitoring and evaluation results;
- Coordination of the participation of local subjects in all 7 ETC programs in which the Liguria region participates for the period 2021-2027 (IT FR Alcotra, IT FR Marittimo, Alpine Space, Central Europe, Interreg Europe, Euro Med, Next Med).

TECHNICAL-IMPLEMENTING STRUCTURE

The management of the S3 is conducted directly by Regione Liguria with the support of in-house operating structures that, on regional input, deal with the implementation and operational management.

In particular, Regione Liguria ensures:

- Coordination of the subjects involved in the process;
- Continuity in relationships;
- Animation at the design level;
- Verification of results.

Department of Economic Development - Strategic Development of productive fabric and Liguria economy

The body that operationally implements the S3.

Its main functions are:

- chairing the Steering Committee meetings
- coordinate and supervise the implementation staff work;
- convene, coordinate and analyse the technical tables;
- definition, management and analysis of the entrepreneurial discovery process;
- definition of the monitoring process and coordination of information flows;
- definition of tools for interregional collaborations;
- definition of a plan (methods and times) for involving stakeholders (including EDP and activities related to S3 review).

The relationships between the Departments of the Economic Development various Sectors involved in the S3 implementation process are formalised through internal Service Orders.

Technical Committee

Composed by Regional representatives managing the various reference funds of S3 actions.

Its functions, in co-ordination with the technical and implementation staff, are:

- definition of the IT platform structure containing the monitoring data;
- coordination of monitoring activities;
- definition of monitoring indicators dashboard;
- Support for the definition of the evaluation plan.

Implementation Staff

It consists of Regione Liguria internal technical resources and external in-house companies' resources (FILSE, Liguria Ricerche), with specific skills in strategic planning and support of the competitive development of the territory and project management in research and innovation.

It is co-ordinated by the Department of Economic Development - Strategic Development of productive fabric and Liguria economy.

Its activities are the following:

- economic technical analysis of the policy context and lessons learned
- drafting of technical documents relating to S3;
- development of the monitoring model (definition of S3 indicators, mapping monitoring information of all S3 tools and definition of data collection process);
- structuring and management of the monitoring platform;
- drafting monitoring reports;
- translation of the outputs of the entrepreneurial discovery process into tool proposals;
- analysis of stakeholder engagement outputs;
- support for the participation in roundtables both at national and/or international level

The Regional Observatory on the research, innovation and higher education system supports the implementation staff in updated data collection relating the reference context by conducting ad hoc surveys and in-depth analyses.

STRATEGIC STRUCTURE

Steering Committee

It is an advisory body of the Regional Council, which supports programming and planning phases in research, innovation and higher education. Currently it consists of representatives of the subjects who form the regional research and innovation system and its task is expressing opinions on programs and initiatives to support higher education, research and innovation and development of the manufacturing sector.

The Steering Committee, appointed by the President of the Regional Council after agreement with the bodies concerned, is composed of:

- a) Three members appointed by the President of the Regional Council, one of whom acts as President;
- b) Three members designated by the University of Genova;
- c) Two members designated by C.N.R. and representing the other research institutions present in Liguria
- d) A member designated by I.I.T.;
- e) A member appointed by the Regional Union of Liguria Provinces (URPL);
- f) A member designated by the Union of Chambers of Commerce of Liguria;
- g) A member designated by the Liguria industrialists' association, a member designated by Liguria artisans' associations, a member designated by the merchants' associations, a member designated by the cooperatives' associations;
- h) Three members designated by the most representative trade union organizations at regional level;
- i) A member designated by Liguria District of Marine Technologies;
- j) A member designated by Liguria Technological District of Integrated Intelligent Systems;
- k) A member appointed by the Research and Innovation Clusters as in article 3 bis;
- l) A member appointed by the Regional Institute for Floriculture of Sanremo;
- m) A member appointed by the G. Gaslini Institute;
- n) A member designated by the I.S.I.C.T.;
- o) A member designated by the IRCCS AOU "San Martino - IST - National Institute for Cancer Research".

Law 2/2007 and subsequent amendments and additions rules the composition, role and function of the Steering Committee.

PARTICIPATION LEVEL (*BOTTOM UP BODY*)

Technical tables

They ensure maximum participation and exchange between the various stakeholders active in the S3 areas; they contribute to the periodic updating of the technological trajectories for each area and to the identification of development opportunities through technological foresight actions.

The Technical Tables are composed of:

- Representatives of the research world;
- Technological Districts and Research and Innovation Clusters which include a large representation of companies, research groups and end users involved in specific issues, born as a real tool for entrepreneurial discovery;
- Business representative organizations (Chambers of Commerce, Confindustria).

Civil Society

Public consultation is envisaged (open to all citizens) through questionnaires that will be published on the Open Innovation platform and advertised through Regione Liguria POR FESR newsletter and any additional channels implemented by the Region itself (S3 monitoring platform).

Civil society consultation first aim is to get feedback on the importance of the areas of specialisation and the strategic nature of the main actions in terms of research and innovation.

9.2 Monitoring and evaluation process

Monitoring is one of the phases of S3 life cycle - and its objective is providing useful data for measuring the degree of implementation of the strategy and the results achieved in order to implement any corrective actions.

Monitoring must be one of the tools to conduct an activity of analysis of the effects on the production systems and on the territory.

S3 monitoring uses both the national and regional systems.

For projects implementing the NSSS²¹ financed with European and national cooperation policy resources, refer to the National Monitoring System. The job made by NUVEC²² with all the administrations holding S3 and with the IGRUE²³ of the State General Accounting Office in 2017 and 2018 merged into the IGRUE-ACT Note of 31 October 2018 "Monitoring of Smart Specialization Strategy projects".

The methodology proposed by NUVEC makes it possible to identify, within the National Monitoring System (SMN), all the projects that contribute to the implementation of the SNSI by national thematic area and of the regional S3 by area of specialisation.

Building the links of correspondence between regional and national trajectories/sub-trajectories provided an opportunity for shared collective learning, useful to understand the underlying assets definitions and the possible convergences between different fields of activity and technologies.

Correlation tables have a threefold value:

- they are an operational support for the inclusion in the National Monitoring System of regional projects that participate in SNSI implementation;
- during the monitoring data analysis phase, they allow a harmonized reading between national and regional levels, reconstructing a coherent flow between SNSI thematic areas, Specialization Areas of the National Research Program and Regional Specialization Areas, otherwise not possible;
- they helps to bring out, with an overall vision, the distribution of regional development priorities, an element that facilitates the identification of opportunities to fill gaps in skills and/or resources in one area with skills and resources in another one, making it possible to build more solid value chains and competitive advantages.

In summary, the adoption of the NUVEC-IGRUE methodological approach has enabled and will allow:

- an overall view, for each thematic area, of the typology of projects financed by the national strategy, with data comparable with those of the regions by specialization area, previously not available;
- the return of comparable information in terms of type of enterprise, demand for innovation and development trajectories at a local level;
- the possibility of supporting policy decisions concerning the definition of appropriate tools aimed at sustaining the innovative capacity and competitiveness of enterprises at national and territorial level.

²¹ *National Smart Specialisation Strategy*

²² *Verification and Control Unit*

²³ *General Inspectorate for Financial Relations with the European Union*

At the regional level, the monitoring process takes place on an annual basis. The subsequent evaluation process should take place every three years.

In detail the monitoring process:

OBJECTIVES	The monitoring process aims to provide information on the progress of S3 implementation and the results achieved. The process results can also be useful for taking any corrective actions.
PROCESS METHODOLOGY	<p>The process starts from the perimeter of areas of specialisation, associated technological trajectories and expected results for each area.</p> <p>Step 1 Definition of the indicators for the objectives</p> <p>Step 2 Collection and processing of data based on the type of indicators</p> <p>Step 3 Analysis of the data collected by the subject in charge</p> <p>Step 4 Annual monitoring report (evidencing the achieved results, those expected, any deviations with consequent corrective actions)</p> <p>Step 5 Validation of the monitoring report by the subject in charge</p>
INDICATORS	<p>The indicators used for the monitoring process are the following:</p> <p><u>Output indicators</u>: measure the output of regional policies in terms of operations carried out</p> <p><u>Indicators by area of specialization</u>: where possible, report a breakdown of the values/counts by area of specialisation</p> <p><u>Strategic indicators</u>: have the goal of evaluating the direction of the changes in progress</p> <p><u>Context indicators</u>: general indicators on variables influenced (but not directly related) to S3 such as R&D expenditure, number of researchers, etc.)</p>
DATA SOURCES	<p>Data used for the monitoring process come from various sources according to the type of indicators:</p> <p>Official sources (ISTAT, EUROSTAT, ...)</p> <p>Data relating to the implementation of European and national programs (POR FESR, POR FSE, ...)</p> <p>Administrative data from regional sources</p> <p>Interviews with sample companies</p> <p>Data provided by research system subjects</p> <p>Data deriving from ad hoc surveys</p>
MANAGEMENT TOOL	IT monitoring platform ²⁴

²⁴ For a description of the monitoring platform, see next paragraph.

Below the details of the parties involved in the evaluation phases:

<u>PHASE OF THE MONITORING PROCESS</u>	<u>SUBJECTS INVOLVED</u>
1. Definition of the indicators	Technical-implementation structure Steering Committee ERDF Managing Authority
2. Collection and processing of data based on the type of indicators	Technical-implementation structure Managing Authority of European Funds
3. Analysis of the data collected by the subject in charge	Technical-implementation structure Steering Committee
4. Annual monitoring report (evidencing the achieved results, those expected, any deviations with consequent corrective actions)	Technical-implementation structure
5. Validation of the monitoring report by the subject in charge	Steering Committee Managing Authority POR FESR Technical Tables

The evaluation activity is complementary to the monitoring one and its aim is verifying the coherence between the strategy and the consequent public action. Therefore, it analyses measures and tools, functioning of governance mechanisms, entrepreneurial discovery as well as the production of acts and regulations pursuing the objectives set by the strategy.

In detail the evaluation process:

OBJECTIVES	<p>The evaluation process on S3 implementation aims at verifying the consistency between the strategy and the consequent public action; therefore, it analyses measures and tools, the functioning of governance and entrepreneurial discovery mechanisms, as well as the production of acts and regulations aimed at pursuing the objectives set by the strategy. Therefore, its objective is the evaluation of effectiveness, efficiency and impact of the measures envisaged in S3 based on a shared evaluation plan that defines the "key evaluation questions".</p> <p>Examples of evaluation questions:</p> <ul style="list-style-type: none"> • What projects are we funding? • Has the collaboration changed the subjects' behaviours? • Does it improve the beneficiaries' competitiveness? • To what extent is the regional system involved? • Has the competitiveness of the regional economic system improved and in S3 areas of specialization? • Has the innovative capacity of the regional system improved? • Is governance effective and inclusive?
PROCESS METHODOLOGY	<p><u>Step 1</u> <u>Evaluation plan drafting, identifying the evaluation questions</u></p>

	<u>Step 2</u> <u>Drafting of the evaluation report on the degree of objectives achievement</u> <u>Step 3</u> <u>Validation of the evaluation report by the subject in charge</u> <u>Step 4</u> <u>Evaluation process' approval</u> <u>Step 5</u> <u>Results diffusion</u>
EVALUATION ACTIVITY	<p>An external subject (POR ERDF independent evaluator) provides a report drafting in order to verify the S3 effectiveness compared to the objectives set and the strengthening of the areas of specialisation.</p> <p>The tender specifications relating to the implementation of the independent evaluation service of the regional operational programme "European Regional Development Fund" envisage a focus on the evaluation of S3.</p>
DATA SOURCES	<ul style="list-style-type: none"> • S3 Document • Monitoring Report • Sample Interviews • Additional Sources

Below the details of the subjects involved in the evaluation:

EVALUATION PROCESS	SUBJECTS INVOLVED
1. Evaluation plan drafting, identifying the evaluation questions	Technical and implementation structure, coordinated by the managing authority Technical Board (After consulting the Steering Committee)
2. Drafting of the evaluation report on the degree of objectives achievement	external subject (POR ERDF independent evaluator)
3. Validation of the evaluation report	POR FESR managing authority Steering Committee
4. Approval of the evaluation report's results	Regional Council
5. Results diffusion	Technical Tables Civil Society

As you can see in the table above an external subject (POR ERDF independent evaluator) drafts a report to verify the S3 effectiveness compared to the objectives set and the strengthening of the areas of specialisation.

9.2.1 Platform Structure

The platform, interactive and publicly accessible online, represents the graphic interface that allows the visualisation of the indicators foreseen by the S3 monitoring, previously selected and coming from official statistical sources (Istat, Eurostat, etc.) and from regional sources (monitoring systems of programs). Public consultation is possible as the monitoring indicators are in statistic and/or aggregate form. Currently the platform presents the contents shown below, but it can be expanded and integrated with new data or sections.

The IT infrastructure contains some pages that introduce the regional S3, its objectives, its developments over time and its monitoring and evaluation process.

The crucial section is the one relating to the **overall monitoring dashboard**, which contains a graphic and interactive view of all the monitoring indicators, divided into the following sections:

- Context indicators
- Specialization indicators
- Strategic and result indicators
- Output indicators

The sections relating to context, specialization, strategic and result indicators present the most recent updated data available, divided among the specialisation areas to which they refer. The views allow the evaluation of the trend over time.

The Output Indicators section collects data from the regional monitoring system about projects funded on S3 measures.

It is possible to filter the main indicators, relating, for example, to the number of financed projects, to the grant allowed, to the private investments activated, to the number of enterprises receiving support and other elements, according to different levels of detail, which include:

- the reference action;
- the reference programme;
- the area of specialisation;
- the kind of project;
- the field of intervention;
- the economic activity.

Indicators are updated according to the reference data release frequency. Allowing having an updated reference framework, both useful for the development of analyses and for the ongoing monitoring of S3 activities.

Below are some visualisations of the S3 monitoring platform.



REGIONE
LIGURIA

S3 Monitoraggio
SMART SPECIALISATION STRATEGY

Strategia Cruscotto di monitoraggio 2014-2020



La Strategia S3 della Regione Liguria

SCOPRI LA STRATEGIA

Cruscotto degli indicatori S3



**Indicatori di
contesto**

[VAI](#) →



**Indicatori di
specializzazione**

[VAI](#) →



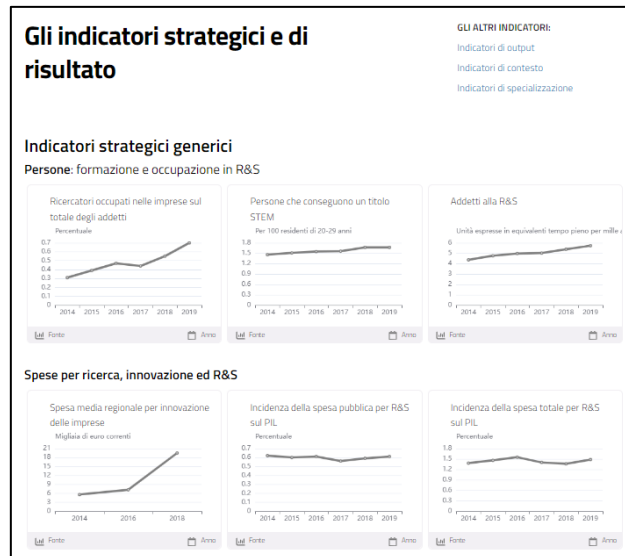
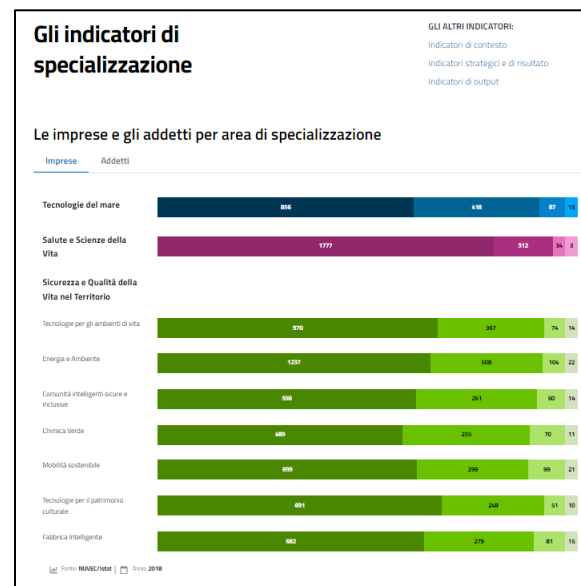
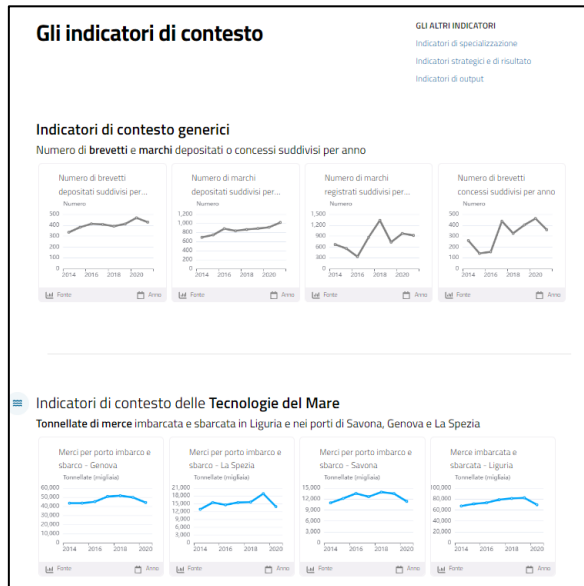
Indicatori di output

[VAI](#) →



**Indicatori
strategici e di
risultato**

[VAI](#) →



9.3 S3: a constantly updating strategy

S3 is, by its nature, an always-evolving document. Its development, implementation and updating process is periodical mostly because of the constant entrepreneurial discovery process, which must be as collaborative and inclusive as possible, consistently with the quadruple helix model.

For this reason, the entrepreneurial discovery process represents, also for the 2021-2027 programming period, a fundamental element for the effective updating and alignment of the identified technological trajectories. In this context we must highlight the relevance of criteria 1, 3 and 4 of the enabling condition "Good governance of national or regional Smart Specialization Strategy" envisaged by the cohesion policies 2021-2027.

To measure the performance and the constant process of entrepreneurial discovery, to monitor the evolution of technology and the indications coming from the regional research system and from the production systems, a dedicated type of analysis is essential. In fact, an updated analysis of the obstacles to innovation diffusion, a constant and well-structured monitoring system will allow the drafting of a coherent document with respect to the emerging needs and technologies of the territory through a bottom-up approach.

ATTACHMENTS

ATTACHMENT 1. Definition and source of the main indicators used in the context analysis

Indicator	Definition	Source
Structural elements and Socio-economic trend in the medium term		
Export capacity	Value of exports of goods to GDP (percentage)	Istat
Ability to export in global dynamic demand sectors	Share of export value in dynamic world demand sectors in total exports (percentage)	Istat
Research and innovation system in the medium term		
In-house expenses	Expenditure on activities for scientific research and experimental development (R&D) carried out internally with staff and equipment managed by the respondent	Istat
Share of total R&D expenditure in GDP	Total R&D expenditure as a percentage of GDP (current prices)	Istat
Share of government R&D public expenditure in GDP	Expenditure on research and development of Public Administration and University on GDP (percentage)	Istat
Incidence of private sector R&D expenditure on GDP	Private sector R&D expenditure (private not-for-profit enterprises and institutions) as a percentage of GDP (current prices)	Istat
Impact of business R&D expenditure on GDP	Expenditure on research and development of public and private enterprises on GDP (percentage)	Istat
R&D personnel	R&D personnel (measured in terms of full-time equivalent units per thousand inhabitants)	Istat
Companies that have performed R&D in collaboration with external parties	Companies that have performed R&D in collaboration with external parties out of the total companies that conduct R&D (%)	Istat
Companies that have carried out R&D using research infrastructures and other R&D services from public or private entities	Companies that have conducted R&D using research infrastructures and other R&D services from public or private entities out of the total of enterprises with in-house R&D activities (percentage)	Istat
Enterprises with innovative activities	Companies declaring having performed activities aimed at the development or introduction of product, service or process innovations in the three-year reference period of the survey. This category includes Innovative companies, companies with activities still in progress at the end of 2008, companies that, in the three-year reference period of the survey, launched innovation projects but abandoned at the end of 2008.	Istat
Enterprises with cooperation agreements for innovation	Cooperation in innovative activities means active participation in R&D projects or projects aimed at product or process innovation.	Istat
Rate of innovation of the production system	Enterprises with at least 10 employees who have introduced technological innovations (product and process) in the reference three-year period as a percentage of the total enterprises with at least 10 employees	Istat
Birth rate of enterprises in knowledge intensive sectors	Enterprises established in year t in knowledge-intensive sectors as a percentage of the number of enterprises active in year t in the same sectors	Istat
Three-year survival rate of enterprises in knowledge-intensive sectors	Enterprises established in year t in knowledge-intensive sectors and surviving in year t +3 as a percentage of the number of enterprises born in year t in knowledge-intensive sectors	Istat
Expenditure on innovation	Expenditures incurred for the introduction of innovations product or process. Expenses include:	Istat

Indicator	Definition	Source
	<ul style="list-style-type: none"> R&D (including outsourced R&D); acquisition of machinery, equipment, software and buildings aimed at innovation; acquisition of knowledge (know-how, copyrighted works, patented and unpatented innovations, etc.); technical and aesthetic planning activities of new products and services (design); other innovative activities conducted internally or by third parties, such as personnel training aimed at innovation, marketing of new products, and other activities preliminary to the implementation of innovations (feasibility studies, verification and testing activities, industrial engineering, etc.). 	
Innovation expenditure per employee	Expenditure on innovation per employee compared to the number of employees of innovative companies	Istat
Production specialisation in high technology sectors	Employees in high-tech manufacturing, knowledge-intensive and high-tech service sectors as a percentage of total employees (total)	Istat
Knowledge workers	Percentage of employees with university education (Isced - International Standard Classification of Education 5-6-7-8) in Scientific-Technological professions (Isco - International Standard Classification of Occupations - 2-3) out of total employees	BES
The new challenges of digitalisation		
Degree of diffusion of broadband in municipal administrations	Municipal administrations that have broadband access out of total municipal administrations (percentage)	Istat
Ultra-broadband coverage at least 30 Mbps	Population with ultra-broadband at least 30 Mbps as a percentage of the resident population	Istat
100 Mbps ultra-broadband coverage	Population with 100 Mbps ultra-broadband coverage as a percentage of the resident population	Istat
Ultra-wide band access	Number of ultra-broadband subscriptions as a percentage of the resident population	Istat
Availability of public Wi-Fi in Municipalities	Percentage of municipalities providing free Wi-Fi access points on their territory out of total municipalities	Istat
Degree of e-procurement used in PA	Percentage of online calls for tenders out of the total number of calls for tenders	Istat
Municipalities with fully interactive services	Number of municipalities with fully interactive services as a percentage of total municipalities	Istat
Local government employees who have received TIC (information and communication technology) training	Number of local government employees who have received TIC (information and communication technology) training	Istat
Degree of citizen participation through the web in political and social activities	People aged 6 and over who have used the Internet in the last 3 months to express opinions on social or political issues through websites (e.g., blogs, social networks, etc.) out of the total number of people aged 6 and over who have used the Internet in last 3 months	Istat
Extent of Internet use in households	Percentage of households with internet access out of the total number of families	Istat
Degree of Internet use in households in the last 3 months	People aged 6 and over who have used the Internet in the last 3 months out of the total number of people aged 6 and over who have used the Internet in last 3 months	Istat
Degree of Internet use in households in the last 12 months	Persons aged 6 and over who have used the Internet in the last 12 months as a percentage of the population of the same age group	Istat

Indicator	Definition	Source
Employees using computers connected to the Internet at least once a week	Employees of enterprises (with more than ten employees) using computers connected to the Internet at least once a week out of the total workforce	Istat
Online sales via web and/or EDI systems (Electronic Data Interchange)	<p>Sales divided into:</p> <ul style="list-style-type: none"> • orders placed via website or web application (online order forms available on the company's website, on the extranet or via an intermediary online shop or web shop, or website of another intermediary company, web applications or Apps) • orders placed through electronic data exchanges in an established format (order through automatic electronic exchanges of data such as EDI messages or for example EDIFACT, UBL-Universal Business Language, XML, etc.) 	Istat
Companies that have a website/home page or at least one page on the Internet	Percentage of enterprises (with at least 10 employees) in the Industry and Services sectors that have a website/home page or at least one page on the Internet	Istat
Enterprises that purchase cloud computing services	'Cloud computing' is a paid service that allows storing, processing and use of data (or TIC services) on remotely located computers accessed over the internet	Istat

Istat: Istituto nazionale di statistica ((Italian national statistical institute).

BES: Benessere equo e sostenibile (Fair and sustainable welfare)

Istat project that measures fair and sustainable welfare, with the aim of evaluating society progress from a social and environmental point of view.