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Meta-analysis of Research and Innovation Strategies for Smart Specialisation: Priorities and Policy Measures

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Executive summary

This report presents a review and elaboration of meta-analysis of Research and Innovation Strategies for Smart Specialisation (RIS3), focusing on the priorities identified by regions/countries, and policy measures at regional and national level.

The first part of the report presents the key findings of a structured dialogue with experienced practitioners from across Europe. It benefits from a methodology of structured interactions with regional and national policymakers, across time, adapting and pursuing a cohort-type approach. It has also relied on results of a Smart Specialisation Platform (S3 Platform) survey of policymakers.

On the one hand, analysis has brought new dimensions to the fore. First, coherent policy road-mapping, fostering regional economic transformation, emerged as a pivotal issue that deserves more attention. Regardless of the label used (policy road-mapping, techno-economic road-mapping, regional transformation road-mapping), the key point is the realisation that there is a host of policies that must be in tune with the transformational promise of S3, in order to reap its fruits. One of the most powerful examples is the importance of human capital for the success of S3 – or any sustainable exercise pursuing growth – and the way S3 can be undermined by relentless austerity drives that push human capital away.

Other notable messages emerged in this meta-analysis, especially through the active structured involvement of front-line policymakers. Quite encouragingly, it was stressed that the Smart Specialisation approach is perceived as a broad development strategy, and not just a mere setting for the use of regional funds. Policymakers also confirmed the importance of maintaining momentum in the Entrepreneurial Discovery Process (EDP), as well as the need to simplify and harmonise financing instruments. Furthermore, certain underappreciated issues have been identified as critical: they include ensuring consistency in communication about the Smart Specialisation approach and policies to stakeholders, and nurturing a continuous dialogue across sectors and disciplines to boost cross-fertilisation.

On the other hand, the review of priorities led to a methodology, which can still be implemented without recourse to computational power at this stage. However, as the number of priorities grows, a programmable algorithm may well be needed. This report hints at how such an algorithm can be built; the goal would be, in a sense, the obverse of what is sought by web navigators' rank algorithms. Instead of seeking many relevant responses to queries, the objective would be to provide concise syntheses reflecting many different contributions, seeking common elements among them. Developing it would require policy backing, and a separate, prioritised, and resource-demanding project.

Finally, the meta-analysis of priorities allows regrouping them to extract common vectors of emphases across regions, as bottom-up input towards mission-oriented themes that carry cross-regional economic transformation potential. Through the process above, eighteen groupings of priorities (priority families) were identified. Some of the highest ranked ones, reflecting many regions/countries priorities, involve activities that are always high in such lists (e.g. health-related); others however entail activities that are often overlooked. One very important such grouping/family, with many countries and regions in its ranks, is the agri-food family, where research and innovation can often be high-tech indeed. Another very important – and usually overlooked – grouping involves tourism and culture. This includes targeted tourism, as well as quality-of-life experiential tourism, and indirectly proposes a new 21st century approach to the concept of competitiveness. Beyond such groupings and examples, the ultimate specific identification of vectors should ideally involve a broader discussion/validation process.

1. Introduction

The present report puts forward a review and elaboration of meta-analysis of Research and Innovation Strategies for Smart Specialisation (RIS3), focusing on the priorities identified by regions/countries, and policy measures at regional and national level.

The first part of the report presents the key findings of a structured dialogue with experienced practitioners from across Europe. It benefits from a methodology of structured interactions with regional and national policymakers, across time, adapting and pursuing a cohort-type approach. It has also relied on results of a Smart Specialisation Platform (S3 Platform) survey of policymakers[1].

For the second part of the report, the meta-analysis of RIS3 priorities, a methodology has been developed, which albeit demanding, can still be implemented without recourse to computational power for current, still manageable, numbers of priorities (of the order of 1000). However, as numbers grow, it is likely that a programmable algorithm may be needed. The report hints at how such an algorithm can be built, in concluding; obviously developing it would require explicit policy backing, and a separate, prioritised, and resource-demanding project.

This analysis has brought two new dimensions to the fore. First, coherent policy road-mapping, fostering regional economic transformation, emerged as an important, and hitherto under-appreciated challenge.

Second, the structured meta-analysis of priorities allows regrouping priorities in ways that can extract common vectors of emphasis across regions, which may correspond to priority groups that are expectedly popular (e.g. health-related), or others that are more surprisingly so (e.g. agri-food or tourism). It can also provide bottom-up input for identifying mission-oriented research themes that carry wide, cross-regional economic transformation potential.

The ultimate specific identification of vectors, however, should ideally involve a consultation/confirmation process, beyond any desk-top analysis. In any case, a separate algorithm-implementing exercise could be envisaged to explore such initial vectors as input to the discussion/selection process. Given the large amount of variables in this case, including the characteristics of sub-priorities, their possible interactions, and the characteristics of the scientific challenges in play for each one of them, the algorithm in question will not be a simple iterative one.

Other notable messages emerged in this meta-analysis, especially through the active structured involvement of front-line policymakers. Quite encouragingly, it was stressed that the Smart Specialisation approach is perceived as a broad development strategy, and not just a mere setting for the use of regional funds. Policymakers also confirmed the importance of challenges related to the revision of national/regional priorities and policy measures, such as trust-building and coordination across multi-level interactions, maintaining momentum in the Entrepreneurial Discovery Process (EDP), as well as the need to simplify and harmonise financing instruments. Furthermore, certain underappreciated issues have been identified as critical: they include ensuring consistency in communication about the Smart Specialisation approach and policies to stakeholders, and nurturing a continuous dialogue across sectors and disciplines to boost cross-fertilisation.

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[1] Launched in 2018 and supervised by one of the authors, D. Kyriakou.

2. Stocktaking of national/regional priorities and linkages with corresponding policy measures

The need for consistent policy sets and coherent policy road-mapping runs through much of the input emerging from structured interactions with policymakers[2].

Three main related challenges were outlined:

- Trust-building and coordination across multi-level governance interactions
Trust-building between stakeholders and the public sector is crucial, before stakeholders change their practices and develop joint activities. Trust building entails notably the elaboration of a common understanding of the S3 concept and its benefits, the development of a common interest among stakeholders around a strategy, and broadening SMEs' confidence in the innovation system. Moreover, the articulation between the national, regional and local level is seen as important in the implementation of S3, especially to put forward a "collaborative leadership approach" that fosters an integrated approach to innovation, with coherent institutional mechanisms between various ministries & politicians. Some regions have emphasized the need to get greater decision-making power at regional level and have pointed out the lack of integration of the Smart Specialisation approach and related EU innovation policies at national level.

- Maintaining momentum in the Entrepreneurial Discovery Process (EDP)
Fostering innovative environments and the active engagement of SMEs and research, providing relevant feedback to stakeholders to find new opportunities and areas of specialisation are necessary and far from trivial tasks. The EDP is acknowledged as a continuous bottom-up process that helps refine and sharpen priority areas[3].

- Simplification of financing instruments
There is a need to simplify the procedure and add some flexibility to facilitate the assimilation by stakeholders and spark behavioural changes. Some regions emphasize the need for greater subsidiarity in the management of ERDF at regional level. The success of strategies will ultimately depend on accompanying policies facilitating the creation and exploitation of new techno-economic paths, promoting collaboration among different types of partners and addressing issues related to joint activities[4] (e.g. IPR issues, free-riding behaviour), and providing incentives to motivate stakeholders to work together.

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[2] Working meetings with a selected number of national/regional experts:
 http://s3platform.jrc.ec.europa.eu/s3-implementation
[3] See the case of Hungary:
 http://s3platform.jrc.ec.europa.eu/documents/20182/337268/V%C3%A4rmland-Sweden_S3-Approach-Impact-assessment.pdf/611ec773-eba3-4154-8baf-eabfb894cd9b)
[4] See the case of Northern Netherlands:
http://s3platform.jrc.ec.europa.eu/-/smart-specialisation-comes-from-the-grassroots

Example 1. Portugal: The challenges of a multi-level strategy[5]

For countries like Portugal, where we have a national plus regional S3s, the horizontal and vertical alignment and coordination is always a challenge. Complementary to that, already in the current FP but more intensively in the next one, complementarities and synergies between the European level and the national/regional levels will play an important role. Even in highly decentralized systems, where regions have a strong role, several challenges call for cooperation with other regions and countries and this demands for a multi-level strategy.

After the midterm evaluation of the different S3 in Portugal, the National Innovation Agency (ANI), identified the situations where, at least apparently, there was potential for coordination and classified them in 3 types:

- Different: no complementarities present, so no need for coordination
- Complementarity: in this case, there was a potential for joint actions, maintaining the different interventions.
- Overlap: where the same (or very similar) activities were developed. In this case, this overlap can be avoid or managed (sometimes, duplication is positive).

It was also important to identify which challenges can be tackled at regional level, those that call for an intervention at national level and also the ones that can only be dealt at European level.

As an example, we can use the case of Renewal Energy:
- One particular Region can focus on one or more types of renewal energy, pushing also for the development of related technologies (solar, wind, waves, etc.).
- But to build an energy system where those different types of energies can connect and serve users, we need an energy grid, and this cannot be dealt at regional level only, we need to consider, at least, the national level.
- Finally, current and future challenges in terms of energy networks will call for a smarter and more integrated energy network at European level, with well interconnected national networks and with a well establish energy market, and this call for actions at European level.

This work is the basis the ongoing process of S3 revision, currently coordinated by ANI, involving all the regions.

Example 2. The case of Tuscany (Italy)[6]

There is much interest in new path creation dynamics, on one side, and in scaling up innovation for existing paths, on the other.

With regards to the latter (scaling-up innovation) this entails the implementation of research results in new product and processes, as well as in the possible diffusion of them within existing supply chains.

With regards to new path creation, this translates to new business areas activated by beneficiaries as a consequence of regional funding related to RIS3, with special attention, for instance, to new business model detected, new industry research partnerships enhanced as well as new competences and skills required. Another important topic within this perspective is the analysis of entrepreneurship dynamics related to main technological roadmaps.

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[5] The challenges of a multi-level strategy, the case of Portugal:
http://s3platform.jrc.ec.europa.eu/documents/20182/337268/PORTUGALRIS3_2Assessement_Workshiop+Sevile_02-04-2019.pdf/1037507f-3413-4078-a39c-5f5a71199d97
[6] The case of Tuscany (Italy):
http://s3platform.jrc.ec.europa.eu/documents/20182/337268/ITALY_Tuscany+Region.pdf/13007406-0791-427e-8e71-d2828632b15a

Revisiting/refining priorities

Some Member States and regions have gone through a mid-term evaluation[7]; others are currently in the process of performing it. In general, there were no major changes regarding the RIS3 update and priorities: fine-tuning the existing priorities, refining sub-priority areas (narrowed down or substituted by others), detecting the new types of collaborations and their economic potential. As the available remaining resources are gradually dwindling, public authorities have tended to focus and hone in their priorities.

In some cases, new dimensions were introduced such as the internationalisation, the territorial cohesion criteria (sub-regional coverage), or addressing societal challenges[8]. Several regions have indeed outlined that thematic priorities should/will further respond to social challenges and integrate business needs[9].

An overall observation emerging from structured interactions – and it is one more instance in which such interactions are a much richer tool than surveys – is that the differentiation between vertical priorities vs horizontal priorities is neither always made, nor always understood. This links back to a more general need for clarity in communicating about S3, to avoid confusions with older, horizontally-focused policies, and, more importantly to enable coherent policy sets and policy road-mapping[10] that will help reap the transformational fruits of S3.

It is worth underlining that the Entrepreneurial Discovery Process (EDP) was widely used to engage with territorial actors[11]. Canvassing and consulting stakeholders is a common way to detect priority areas and activities - through interviews, monitoring the level of interest in a priority (e.g. through monitoring responses to calls for proposals). The indicators used largely related to the Operational Programmes (ERDF, ESF, EARDF) and were mostly output, outcome and results indicators. Monitoring system and collection of data are closely related to the OPs.

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[7] E.g. the case of Lithuania: http://s3platform.jrc.ec.europa.eu/-/s3-interim-evaluation-stakeholders-hands-on-the-steering-wheel?
[8] The case of Lapland, Finland: http://s3platform.jrc.ec.europa.eu/documents/20182/337268/Revision+of+S3-Consistency-Coherence.pdf/7a374563-eeb8-41e0-ac92-a721b1c3a72a
[9] The case of Castilla y Leon (Spain): http://s3platform.jrc.ec.europa.eu/documents/20182/337268/Castilla-Y-Leon_S3_Priorities-Related+Policies-IA.pdf/e2037a09-37eb-48bd-bff5-db79cffac786
[10] The case of Crete (Greece): http://s3platform.jrc.ec.europa.eu/documents/20182/337268/Next-Generation-RIS3_Crete-Greece.pdf/ef0d8d50-e234-4442-a54d-381e33ecbc28
[11] The case of Värmland (Sweden): http://s3platform.jrc.ec.europa.eu/documents/20182/337268/V%C3%A4rmland-Sweden_S3-Approach-Impact-assessment.pdf/611ec773-eba3-4154-8baf-eabfb894cd9b

Example 3. The case of Castilla y Leon (Spain):

For the next programming period, it is expected that the smart specialisation priorities will still be based on the Regional Specialisation Pattern (RSP), but with some important changes:
- The RSP defined in 2013 during the elaboration of RIS3 2014-20 was based on existing strengths from the economic, scientific and technological points of view; but the mid-term evaluation stated that the methodology used to elaborate the RSP did not allow to identify new emerging activities that could provide opportunities for the region, and the solution proposed was the use, in the Pattern's Economy pillar, of flow variables instead of volume (static) ones.
- But it still posed the problem of the difficulty of anticipating future trends, so some kind of prospective, qualitative analysis, based on the entrepreneurial discovery process and on other more specialised techniques, will have to be introduced in order to identify future trends, both global and local.
- Also, as it has already been done in the flagship initiatives, not only existing or future strengths will be taken into account in order to identify the smart specialisation priorities, but also the present and still to come needs and challenges of both the society and the business tissue. Again, for that, the participation of the quadruple helix will be crucial.
- A fourth dimension will be included in the RSP: Education and Training, in order to add an interesting perspective regarding the future possibilities of development of new activities in the region, since they should be based not only on existing economic, scientific and technological strengths in the region, but also (and especially) on the rightly qualified personnel.

Example 4. The case of Lithuania

The interim evaluation took place at the end of 2018, as foreseen in the regulation. Although it is too early to discuss the impact of S3 for the economy, it is possible to understand the "traction and direction" of implementation, to search for various signals and take action. Along evaluation of available data from monitoring, the official EDP process was re-established, involving relevant stakeholders. Overall, 130 participants from research and business fields participated and 42 workshops were organized, in view of assessing the policy mix, the relevance of the priorities and other criteria.

It was found that the concentration of investments was insignificant, mainly due to low intensity of financing. 45% of the applications were rejected, mainly due to their proposals' lack of R&I activities. Too detailed a specification of priorities in the official documents can become an obstacle for innovative ideas, because the evaluators would look for certain keywords rather than the logical connection. "Super-priorities", meaning those that would perform in every aspect of intervention, have not emerged yet.

The main decision was to abandon the logic of two-level hierarchy S3 priorities and stay with the broader and more inclusive single level. Out of 6 priority areas and 20 priorities, 7 priorities were reformulated with the involvement of EDP stakeholders. It was decided to renew the list of corresponding technologies (as the previous one was from 2012) in the new priorities, although their titles/designations remain almost the same. The project selection should be based on the potential to address important problems/societal challenges. This will allow to receive more applications and encourage further cross-sectorial approaches.

2.1. Coherence/consistency and implicit policy road-mapping

It also emerges from the structured interactions with policymakers that consistency[12] – in terms of national/regional priorities and the related policy measures implemented/planned on their basis - has been pursued through efforts to align policy instruments with RIS3 (with varying levels of success), and the EDP is largely geared to facilitate this. Sharing regional concerns/issues at national and even at European level is sought, though it is not always straightforward.

Coherence is pursued, as witnessed in project calls selection (though here, one must underline the importance of co-financing regulations, and the role of tools such as the 'Seal of Excellence'). State aid rules are often impediments, and competition regulation imposes important limitations; moreover, combining ESF with ERDF is allowed but very difficult to implement (leading to so-called implementation 'acrobatics'). A concomitant and persistent demand for simplification in the regulations is often voiced in this context.

Complexity of coordination between various levels of government, and different levels of responsibility, is a harder problem, which is often complicating the pursuit of consistency/coherence. Nevertheless, many of these problems (e.g. the mismatch between policy instruments (OP) and the strategy (RIS3), should be smaller in the new programming period (thanks to capacity building, accumulated experience/knowledge, and the supportive role of the S3 Platform[13]).

Overall, it is recognised that coherence is crucial, and the ease of achieving it depends on the overall policy mix, which is often undermined by decisions beyond the region, or even the Member State. It is important in this regard to redresses misalignment between policy instruments at different policy levels (e.g. pushing in opposite directions regarding growth).

In any case, it bears repeating that the S3 approach is recognised as a useful approach: regions and Member States are improving their RIS3 beyond the mere fulfilment of ex-ante conditionalities. The Smart Specialisation approach is widely embraced, as is the knowledge acquired through it.

Regarding policy road-mapping specifically, a central question is whether policy road-mapping[14] for RIS3 is conceived in a holistic way, or, rather, in a more business-as-usual fragmentary fashion. The road-mapping exercise is not yet systematic, is more implicit rather than explicit. On the other hand, there is an increasing realisation of its importance and some initiatives are emerging, even if belatedly, i.e. in the implementation phase, and not in the conception phase (pointing to one more instance of learning-by-doing). Often, policy road- mapping is addressed in a fragmented way rather than systematically, for two reasons – one of which is amenable to policy action, and another one is a more intractable/unpredictable issue. The former reflects the characteristics of decision-making systems, and whether they are set up to do that. The latter, and less tractable one, reflects the personalities of those involved in these decisions.

Capacity-building – reflected in governance structures – and the EDP are recognised as important elements for pursuing coherence and policy road-mapping. EDP continuity can help with boosting the holistic characteristics in implementation. More generally, the approach to EDP affects policy measures and their consistency/coherence with RIS3[15].

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[12] The case of Andalusia (Spain): http://s3platform.jrc.ec.europa.eu/documents/20182/337268/Andalusia-S3-Coherence-Consistency-2.pdf/8a54513e-2cb1-4ae5-b90c-dba6da0d902a

[13] Report from the working meeting " Smart Specialisation Strategies implementation: Priorities, Related Policies and Impact Assessment":
http://s3platform.jrc.ec.europa.eu/documents/20182/337268/Report+S3+workshop_FINAL.pdf/fa184c15-b5e8-4a54-a968-98eebd4a888b

[14] See the case of the Tuscany Region (Italy): initial reflections
http://s3platform.jrc.ec.europa.eu/documents/20182/337268/ITALY_Tuscany+Region.pdf/13007406-0791-427e-8e71-d2828632b15a

[15] The case of Region Sud Provence Alpes Côte d'Azur (France):
http://s3platform.jrc.ec.europa.eu/documents/20182/337268/France-Region+SUD_S3+Priority+revision.pdf/0bbd75dd-dc7c-4410-83ef-e73cd3f7bf7b

Much depends on the level at which RIS3-related decisions are made, in terms of governance structures. Closeness to the highest echelons of decision-making should enable the pursuit of coherence and effective policy road-mapping.

Example 5. The case of Crete (Greece):

2.2. Critical under-appreciated challenges on the road ahead

One cannot stress enough the importance of explaining clearly and consistently the Smart Specialisation approach to stakeholders and make sure that it is well understood. RIS3 is not simply about technological change, it also encompasses new organisational features and new models of interactions among key stakeholders. Hence, strong emphasis should be put on adequate communication and dissemination to get a wider range of stakeholders involved in the S3 process. One suggested way is to make S3 data accessible to a wider audience.

Another key challenge is to identify the right interlocutors and to motivate stakeholders to participate in the RIS3 approach for the long haul, and further target their activities along the line of the S3 priorities identified. Public institutions play the role of facilitators and need to develop the right argumentation with the adequate

policy support instruments to maintain momentum and ensure that the S3 priorities are revised/refined on an on-going basis, according to the economic context[16].

Maintaining such momentum, within a context of policy road-mapping is not simple. For instance, major companies that are already performing well often do not see the need to engage in S3 related activities. It can be particularly difficult to convince them of the potential benefits of participating in R&D projects sharing knowledge with outsiders. There is an overall reluctance to change and a stakeholders' risk aversion attitude. This is exacerbated by the rules complexity often overwhelming SMEs when it comes to participating in EU funded programmes; developing an effective support system would help consolidate their commitment.

In terms of content, there is a constant need to integrate an array of ground-breaking new technologies in the S3 process, as well as a need to launch and nurture a continuous dialogue across sectors and disciplines, in order to boost cross-fertilization. This is easier said than done; as the old quip goes, the first thing a discipline does is to create a jargon that serves as a barricade vis-a-vis other disciplines.

Besides, the skills needed by the public sector and stakeholders to launch, nurture and engage in these exchanges are not always available. And statistical data – which is also often not available – provides at best a snapshot of what has been. Exclusive reliance on the past may hamstring a regional economic transformation agenda such as the S3. It should be complemented by forward-looking analysis, qualitative input, to avoid reducing the process to a backward-looking stationary exercise.

This underlines once more the importance of coherent policy road-mapping, as implementation moves forward, and as the S3 approach evolves. After all, one of the key messages emerging from structured interactions with regional policy-makers, is that the Smart Specialisation Strategy (S3) approach is viewed already at a higher level of development strategy, and not simply as a prerequisite agenda for the investment of regional funds.

Responses from the S3 Platform's 2018 survey[17] (Kyriakou, 2019) provide further evidence on the above. Respondents favoured various accompanying policy measures in other areas as most useful, including support to (collaborative) R&D projects, innovation support services, support for the creation and strengthening of innovative SMEs, support for business organisations, clusters, innovation networks and platforms, improvements of skills and competences. On the other hand, pilot and demonstration projects, support for R&D infrastructure, support for researchers' mobility, public procurement for R&D, or fiscal incentives for R&D were considered less important by respondents.

Regarding coherence of the policy mix and policy instruments, 4 out of 10 respondents saw substantial or drastic improvement in this structural funds cycle, 4 out of 10 saw only moderate improvement, and 2 out of 10 saw little or no improvement. Regarding prioritisation, 6 out of 10 respondents saw substantial or drastic improvement in this structural funds cycle, 2 out of 10 saw only moderate improvement, whereas 2 out of 10 saw little or no improvement. Regarding the revision of priorities, 1 out of 5 respondents to the 2018 survey indicate they are planning or executing RIS3 revision, including revisiting of priorities.

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[16] The case of Poland:
http://s3platform.jrc.ec.europa.eu/documents/20182/337268/POLAND_Sevilla+Beata+Lubos+revision+and+improvement+
+monitoring+bodies.pdf/5193df08-85b2-449a-8a5d-4325d8fcac18

[17] The survey sought responses from policy-makers in more than 170 regions and 18 countries. A total of 71 valid responses were collected (at a response rate of more than 10%) mostly from regional authorities. In the vast majority of cases respondents are part of the RIS3 management team in their respective administrations. For more on the structure of the survey, cf. Guzzo et al. (2018).

Meta-analysis of priorities on the basis of Research and Innovation Strategies for Smart Specialisation (RIS3)

2.3. Meta-analysis of priorities: On Method

Next, attention turns to the desk-top part of the meta-analysis work. Hundreds of RIS3 priorities have been distilled, corresponding to EU countries and regions. In the process, priorities have been transposed into a set of reinterpreted broader and inter-sectoral, inter-disciplinary priority groupings. The word transposition is not casually chosen: from sets of priorities hanging below each country's or region's name, re-interpreted priority groupings/families are obtained, each pointing to an array (or, more properly, a linked list) of countries/regions, namely those regions/countries whose RIS3 priorities are mapped onto each new priority grouping. Expectedly the mapping is not one to one, but rather many-to-many, since each RIS3 priority often has many elements, each of which may be mapped onto a different priority grouping, and each grouping will represent elements from different RIS3 priorities.

In practice, this entails going over the priorities, region by region and country by country, and creating families (more accurately potential families) as you go along. As one moves from region to region and new information is coming in, one needs to update the families of priorities posited, not only in the obvious sense of adding members to them, but more importantly in terms of creating new ones, subsuming previous ones under new more inclusive categories.

It is similar to the process of grouping points/evidence/arguments when doing a review of large bodies of background research. It is quite a demanding process, which can be done up to a certain level/number of priorities (in this case close to, but less than a thousand).

As the numbers grow however (for instance, as new priorities are added, or if local/urban level priorities are added in the future) the numbers will eventually become unmanageable. This is where one would need computerised algorithmic approaches that would generate vectors, or similar ways/terms to encapsulate the resultants of the exercise. Algorithms of this sort may use word concordance tools, graph theory, etc.

More specifically, and with the requisite policy backing/recognition, an algorithmic approach could be developed exploring the interplay of graph theory flow algorithms and linkage-rank algorithms, such as the ones that are behind the structure of well-known internet navigators. Contrary to what is often thought, the theory behind them is not secret; what is proprietary is the coding/shortcuts that guarantee enormous speed in implementation.

Leaving aside potential future computerisation, the first step in the process has included arduous revisiting/recasting of priorities[18] for hundreds of regional/national priorities by S3 platform colleagues to render them succinct and usable. The resulting set was processed in a way combining 'greedy' algorithm and dynamic programming approaches. These are both used in similar cases where global inference algorithms apply, such as multiple document summarization, or more generally information retrieval and natural language processing problems. Greedy algorithms are often used as first approximations for such problems: they are worst-case polynomial-time, and have well-known advantages and disadvantages, especially when they are applied to global inference problems that are reducible to other well-known and well-studied problems. Dynamic programming algorithms also provide approximate (i.e. not exact) results in cases where redundancy exists (as in this case). They feature however smaller errors than greedy ones; on the other hand, their worst case performance is not as attractive as for greedy algorithms (i.e. they are not worst-case polynomial). Note here that divide-and-conquer algorithms would not be useful in this case, since the sub-problems in which the problem can be divided are not neatly separable, but are rather overlapping.

An approach akin to greedy algorithm builds a first basic mapping of RIS3 priorities onto the new priority groupings for two regions, and then uses the fundamental characteristic of the dynamic programming approach, recursively looping back to expand it to three, four, etc. regions/countries. As explained above, even if this process were applied to numerical examples, it would only provide approximate, 'workable' but not exact solutions/answers. This is even more evidently so in non-numerical cases, such as the ones facing us here.

In practice, since the elements of these sets are not numbers, but rather concepts to be interpreted and regrouped, the process is akin to the process of writing a book on a broad subject, organizing a mental scheme during background reading, and updating the structure and main points at every step of the background reading process. It is a difficult process – which is why all authors at some point decide to stop receiving input (background reading), and start writing. Correspondingly, in the case of meta-analysis of priorities, with each new RIS3 set of priorities being reviewed, there is a new round of parsing and updating of the priority groupings, as well as of the membership in them. A snapshot of the outcome of this multiple-parsing is given in the annex. It is important to underscore that the picture is continually changing, as new priorities may be included, old ones may be updated or confirmed, etc., since this is an ongoing process.

It is worth noting that the process has much in common with the recently unveiled RankBrain algorithm – without its reliance on artificial intelligence, since the problem size is still manageable. RankBrain is a type of algorithm that relies on machine learning (i.e., a programme that can automatically access data and use it to learn and improve from experience) to sort through all of the possible search results for a user's query and rank those results in the order that will best meet the intent and needs of that user. RankBrain is used to improve the ability to relate individual web pages to broader concepts, which in turn is designed to increase the usefulness and relevance of search results. RankBrain functions by using "word vectors" – groups of words that are similar to each other linguistically – to guess what people mean when they enter a search query and adapt the results it delivers accordingly. It can do this by using datasets that are vastly larger than what was possible in the past and the outcome is a notable improvement in the quality of search results.

The goal here is in a sense the obverse of what described above in the case of web navigators: instead of seeking many relevant responses from synthetic/dense queries (which is the web navigator's goal), in meta-analysis of priorities, one aims to provide concise syntheses reflecting many different contributions, seeking common elements between them. This will likely be useful, if and when a decision is made to pursue the implementation of an algorithm to deal with higher order instances of the problem.

To continue outlining the foundations of such an edifice, what is sought is not simply a static set of linkages, but also potential dynamic synergies between them. This suggests that flow-concepts and flow algorithms should be considered as well, if such algorithmic implementation is ultimately pursued.

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[18] Eye@RIS3 web tool: http://s3platform.jrc.ec.europa.eu/map

2.4. Meta-analysis of priorities: Results and discussion

Input from meta-analysis of RIS3 priorities can provide a bottom-up anchor and help link it to actual concerns regarding industrial competitiveness and challenges that are shared very widely across the EU. The raw material then exists to help complement the top-down approach implicit in the inspiration of the mission-oriented model, with bottom-up vectors, articulating its possible operationalisation with the recently identified aspirations of European regions/states (i.e those that should ultimately embrace and support it).

Through the process above, eighteen groupings of priorities (priority families) were identified.

Below a snapshot table is given of families of priorities (in parentheses the number of RIS3 with a priority assigned/belonging to this family). Since priorities are in a flux (updated, rephrased, etc.) any such table would have to be a snapshot of what was available as confirmed at a point in time.

Priority family	Sub-categories	Number of RIS3 reflected
Health care and life sciences	biomed and quality of life, rehabilitation, medical devices, radiation impact/protection, diagnostic imaging, nuclear medicine, genomics, drug-delivery, e-health, ageing, home care, telemedicine, intelligent captors/sensors, monitoring, integrated patient care, regenerative medicine, cellular engineering, personalized health care, public health	124
Agri-food	culture of nutrition/gastronomy nexus (unique varieties, biodiversity, quality of life), sustainable agriculture (+biomass, bioenergy, by-products), water management, food safety and security, traceability, bio-captors, cosmetics, livestock breeding and genetics	116
Renewables, smart energy	system management, efficiency, storage, distribution, smart grids, marine energy, power plant dismantling	96
Green technologies	Integrated waste management, environment-sustainability, biodiversity, high-resource-consuming activities analysis and management, water management, recycling, impacts of environmental factors, green chemistry, natural resource preservation/use, biotech for production, environmental crisis prevention and management, bio-economy	93
Efficient processes, Smart materials ('soft' aspects)	Smart manufacturing, advanced industrial processes (smart textiles, materials for microelectronic and industrial applications, digital simulations, transport), industrial automation, design-based-goods – smart, 'software' aspects	86
Digital knowledge and creativity	Digital representation, imaging, sound, educational applications, e-learning, digital economy, Internet of things, robotics, human-machine interaction, big data, safety and security, photonics, lasers, telecoms, augmented reality applications, equipment	83
Smart mobility	transport (sustainability, environmental impact), automotive industry, logistics/multimodality, new vehicle propulsion systems, testing, traffic management, noise reduction, transport safety, security	75
Tourism & culture/creative	Targeted tourism, art, crafts, ICT as a catalyst, experiential, medical , well-being tourism, ecotourism, natural habitat,	74

industry	innovative preservation methods, cultural heritage	
Horizontal aspects – knowledge-innovation nexus	innovation diffusion, hands-on entrepreneurship, finance, human resources, equal growth opportunities across territories, growing pains (scale challenges, niches in export markets & global value chains, investment attraction, etc.), ICT-boosted production/export of goods/services, traceability, biotech, polymers, 'silver' economy, remote sensing, monitoring	70
Advanced materials – 'hard' aspects	structural materials and metals, mechano-welded assembly system manufacture and maintenance (applications defence, shipbuilding, solar energy, transport, wind turbines), nanotech, plastics, graphene – thermomechanical hardware aspects	64
Eco-urbanism	Eco-construction, building energy efficiency, intelligent buildings, building materials, urban management	52
Blue economy	fisheries, aquaculture, food safety–pathogen protocols, maritime tourism, marine archeology, reuse of waste, marine industries, maritime technologies, naval construction, coastal economy	41
Social Innovation	inclusiveness, education, social economy	24
Aeronautics	Aeronautical, Aerospace, Defence industries	23
Machine industry	Machine industry, machine tools, instrumentation	20
Mining	Mining, offshore exploration/mining, natural resource extraction	17
Complex system engineering	Complex applications environment software, energy, health, mobility, embedded systems reliability, embedded software and connected objects	8
Humanities	Humanities and Arts	8

A very important grouping/family, with many countries and regions in its ranks, and one that is often overlooked is the agri-food family, where research and innovation can often be high-tech indeed – e.g. gastronomic nutraceuticals, biodiversity as investment, synthetic biology, etc.

Synthetic biology and exploring/exploiting its possibilities is a topic that actually cuts across groupings (green technologies, health and life sciences, materials, etc.). Another such cross-cutting topic would be graphene and its potential uses (due to its light weight, high resistance and conductivity), which could be explored in surprising combinations – e.g. tissue engineering, lattice structures, replacing/repairing human sensory processes. The latter is related to other issues that cut across groupings, namely human-machine interaction, and alternative physical forms of computing, such as quantum computing, or chemical film computing.

New materials and their characteristics form two important priority groupings, one focused on thermomechanical, 'hard' aspects of new materials, and the other on ´soft' aspects of smart materials, which interestingly link back to the aforementioned topic of chemical computing. An interesting example of a type of

cross-cutting materials of interest to different priority groupings, are biomaterials (e.g. enzymes in this case) that literally consume the remains of oil spills or similar environmental threats.

These are largely technology-specific themes. An example of a transformative theme/goal that is reflected per se in priorities would be fossil-free cities or metropolitan regions by 2040 or 2050. A related one, under the grouping of smart mobility, revolves not around driverless cars per se, but rather the systemic change that would have to accompany them.

Another very important – and usually overlooked – grouping involves tourism and culture. This includes targeted tourism (agri-tourism, medical tourism, gastro-tourism, etc.) as well as quality-of-life experiential tourism (linked to living labs - quality of life). Since this is a largely overlooked area that involves transformative aspects, it is worth exploring further.

The old, traditional tourism model was based on a quick escape to a playground module (e.g. all inclusive) for 2-3 weeks, and/or a trip down memory lane to the old country or a place that is quaintly traditional, or a cultural Disneyland type visit.

The new tourism mode seeks and offers a chance for shaping experiences (even transformational). An emphasis on well-being, design aspects and city-branding, country-branding and attractiveness aspects are crucial in this context.

This indirectly brings forth a 21st century definition of competitiveness, and its relation with the industry of well-being. Copenhagen is a case in point in recent years, enjoying 7% tourism growth per year, while building itself up as a knowledge region seeking to attract 3 top US universities (Ivy League level) and 1 Chinese similar institution by 2025. The two goals are pursued in parallel and feed off each other, which is in tune with a latent recasting of the concept of competitiveness.

Competitiveness is a 'fuzzy' concept and not often clearly defined. It has been used in ways that range from making it effectively synonymous to profitability, to market share, to trade surpluses, to high-value-added exports, to high wages, etc.

However, competitiveness can be seen as a measure of a society's ability to allow economic entities of all sizes, to foster increasingly coveted skills, capacities and products which are differentiated, hard to reverse-engineer, and are handsomely rewarded. Key for success in this sense is the ability to attract the capital (human and otherwise) to generate and nurture economic entities which can compete successfully worldwide, on a social fabric which can absorb the social tensions bound to emerge as demand shifts, skills need updating and adjustment is often inevitable.

To put it in a nutshell: competitiveness marks societies which generate and nurture economic entities (from individual to large firms) which can flourish and perform successfully in world markets, and to which human (and other forms of) capital is attracted. Competitiveness implies attractive societies in which to live, work and invest.

3. Concluding remarks

This paper reports on meta-analysis of RIS3 strategies focusing on the priorities identified and policy measures at regional and national level. Analysis has brought three new dimensions to the fore.

First, coherent policy road-mapping, fostering regional economic transformation, emerged as a pivotal issue that deserves more attention. Regardless of the label used (policy road-mapping, techno-economic road-mapping, regional transformation road-mapping), the key point is the realisation that there is a host of policies that must be in tune with the transformational promise of S3, in order to reap its fruits. One of the most powerful examples is the importance of human capital for the success of S3 – or any sustainable exercise pursuing growth – and the way S3 can be undermined by relentless austerity drives that push human capital away.

Second, the review of priorities, led to developing a methodology, which, albeit quite demanding, can still be implemented without recourse to computational power, at this stage. However, as their numbers grow, it is likely that a programmable algorithm may be needed.

This report hints at how such an algorithm can be built; the goal would be, in a sense, the obverse of what is sought by web navigators' rank algorithms. Instead of seeking many relevant responses from synthetic/dense queries (the navigator's goal), the objective would be to provide concise syntheses reflecting many different contributions, seeking common elements among them. Moreover, one would not seek to portray merely a static set of linkages, but also potential dynamic synergies between them. This suggests that flow-concepts and flow algorithms should be considered as well, if such algorithmic implementation is pursued. Obviously developing it would require policy backing, and a separate, prioritised, and resource-demanding project.

Third, the meta-analysis of priorities allows regrouping priorities in ways that can extract common vectors of emphases across regions. It can also provide bottom-up input for identifying mission-oriented research themes that carry wide, cross-regional economic transformation potential. The ultimate specific identification of vectors should ideally involve a broader discussion/validation process, beyond any desk-top analysis.

Additionally, a separate algorithm-implementing exercise could be envisaged to explore such vectors as initial input to the discussion process. Given the large amount of variables in this case, including sub-priorities, their possible interactions, and the characteristics of the scientific challenges at work for each one of them, the algorithm in question would not be a simple iterative one, and may entail some of the qualities mentioned above, regarding flow and rank algorithms.

In closing, both in terms of the possibilities highlighted by the meta-analysis of priorities, as well as in terms of the importance of policy road-mapping to help realise the potential of S3, the identification of priorities is far from the end of the story. It is at most the end of the beginning.

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