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International study on Scientific Service Companies

Report

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Executive summary

This issue to solve in this study is how Scientific Service Companies (SSCs) can become viable and profitable service companies. SSCs are relatively new companies offering for-profit services to science and business. With their expertise and services, they are the perfect in-between.

It consists of two main parts: the results of a survey and workshop, and a market analysis. From the survey and workshop three main topics pop-up for better development of SSCs: (1) lack of visibility (and clarity on the value proposition); (2) the dynamics of the ecosystem (and the need to remain at the forefront of technical developments); (3) market developments (exploring new markets). The market analysis includes a focus on New Materials as a promising segment for SSCs. Results were also presented at the CAROTS final conference on 21 September 2021 called: Innovation cohesion: a new approach to support industrial R&D.

The analysis and conclusions reveal that market perspectives are good, but that SSCs must be more visible and ensure that they remain at the forefront of developments. Platforms for training (like SSC Start-up School), but also for sharing expertise and co-creation with research infrastructures and industry, can help. Existing support schemes (for starting up, for the growth phase) should be extended to foster innovation of SSC tools and services during all phases. National and European support can create level-playing fields and foster the development and growth of SSCs.

1 Introduction

1.1 Problem

SSCs fulfil important roles between science and industry[1], and they can unleash the potential of knowledge that is in these companies, but also at universities and the research infrastructures. **The issue to solve is how Scientific Service Enterprises (SSCs) can become viable and profitable service companies**.

Although SSCs exist in many shapes and forms, most of them are SME's for which a number of persistent challenges are relevant: the ECB[2] identifies six main challenges for European SMEs:

1. Finding customers;
2. Availability of skilled staff or experienced managers;
3. Regulation;
4. Competition;
5. Costs of production or skilled labour; and
6. Access to finance.

In order for an SME to upscale, its customer base has to grow, in national and/or international markets. And to adapt the production process and develop new and attractive products for business clients and institutional customers, SMEs require a mix of skills at medium to high skill levels. Therefore, a related challenge is finding skilled staff. This includes, for example, engineers, process operators and experienced managers. Furthermore, a large number of SMEs report that access to finance is insufficient; it does not allow for investing in new technologies and investing in new or upgraded skills. For the other factors, the magnitudes fluctuate (due to economic cycles and to country-effects). It also depends on the individual SME (management, age, size, reputation, level of internationalisation, etc.) and its industry.

In addition, SSCs hold specific problems, like access to research infrastructure equipment or sets of instruments; knowledge-based resources such as collections, archives or structures for scientific information; ICT-based infrastructures such as grid, high-performance computing, and software tools. Moreover, they must compete with universities (incl. TTO's) and RTO's that are partly sponsored by governments, and the science sector is rather traditional and not used to outsource (specialised) work – with pharmaceutical research being the exception.

1.2 Scope

Scientific Service Companies carry out research and measurement services at (public) research infrastructures on behalf of industrial clients and provide targeted expertise in many technological and scientific fields on a contractual basis[3]. Over time, the emphasis shifted towards infrastructures and excellence in research became more important (while 'simple analyses' became less relevant).

Our **scope** will be on the SSC's that focus on this scientific excellence – the two types of SSC's that are distinguished by the CAROTS project: SSCs specialised in measurement and analytical methods, and on SSCs specialised in material systems. In this analysis we will include competing companies, including Research & Technology Organisations (RTOs), universities and Contract Research Organisations (CROs). Hence, we will focus on a subset of the Core and Secondary CAROs (Commercial Analytical Research Organisations) that were mentioned in the CARO Market Analysis (2020).

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[1] Cf. CAROTS Conference Report, 2020.

[2] European Central Bank (2016). Survey on the Access to Finance of Enterprises in the euro area, Frankfurt am Main: European Central Bank.

[3] CAROTS Policy Brief (2020).

1.3 Structure of the report

The report has two empirical parts: a survey in combination with a workshop, and a market analysis, that is, desk research enriched with interviews.

We start with the results of a survey that focused on **bottlenecks** and a gap analysis on **'readiness to market'**, considering the typology and findings of our desk research. We aim to picture this for different SSC-typologies (type, size, sector, etc.). The survey results are combined with the outcomes of a CAROTS focus group meeting that was organised by the CAROTS project in cooperation with Science|Business on 1 September 2021.

The analysis of the **development of existing SSCs** will require desk research analysing the current SSC markets by sector, the competing services, and regional developments and trends in research and innovation. In this task, we will **update** and enrich already existing information about SSCs for the recent 2019-2021 period. This update will include Core and Secondary CAROs. The market study is combined with interviews to discuss forward looks.

2 Results of the survey & workshop

2.1 Setup

The survey focuses on the barriers for SSCs according to ECB (cf. section 1.1) and the *Public Support Programs for CARO's Report* (2020). In a workshop the first results of the survey were discussed and we had periodic meetings with the client.

In collaboration with the client the sample was determined, including (e-mail) contact addresses. We used Checkmarket as online survey tool.

The questionnaire was discussed with and approved by the client. To limit the burden for respondents, the survey mainly consisted of closed questions.

Table 1 Blocks of the survey

Block	Question categories	Remarks
A. Typology	Closed boxes on Sector, size, age, number of employees, region, …	Determine the phase of the SSC, collect general info and market potential
B. Customer Base	Type and nr of customers; Type and size of network/ecosystem; Distribution channels; Market estimate.	
C. Infrastructure	Value config (Labs, Instruments); Capability (own facilities, required access to RI facilities) & easiness / difficulties w.r.t. access; Key partners, long-term agreements / cooperation.	Possible bottlenecks w.r.t Infra
D. Financial aspects	Cost structure (assets); Revenue model; profitability; presence of investors/banks.	Bottlenecks w.r.t. finance
E. Visibility	Website traffic; social media presence.	Limitations / lack of visibility to customers
F. Human Capital	Expertise of staff; training facilities; wage structure.	Connect with socio-economic info from the MS.

CAROTS survey 2021

2.1.1 *Fieldwork*

From the population of SSCs and adjacent companies, a sample set was determined and contact persons received an invitation by email, explaining the purpose of the survey and a recommendation letter from the client. In the sample the adjacent (non-SSC) companies were overrepresented as we expected their response would be lower. We aimed at an average response of 20-25%, but actual response rate was 6%. This low number could be explained by the period the survey took place: this was July and August due to the timeline, and the largest part of the sample consisted of non-SSCs – as the population of SSCs is limited. We did send two reminders and there was a call in the Science|Business newsletter. Especially the latter initiated additional response effects. In addition, only a small part of the respondents filled in the complete survey: only 15 out of 51. Again, this could be because many questions were dedicated SSC-questions.

2.2 Results

The frequency tables of the questions are in the annex. In this section we discuss the main outcomes. An intermediate result of the survey was discussed at a CAROTS workshop organised by the client and Science|Business on 1 September. Here we could also check the preliminary findings from the survey.

From the survey and the workshop three main topics pop-up for the development of SSCs:

1. Lack of visibility
2. Ecosystem
3. Market

2.2.1 Visibility

One aspect is their lack of visibility. We were confronted with this ourselves when constructing the sample. There is no specific NACE code and SSCs are categorised by the field of activity and distributed over several NACE codes. Moreover, SSCs are young and small companies which hinders findability as well – for us, but especially for potential customers. Secondly, they have small marketing & branding budgets. And most SSCs don't have the intention to increase their marketing activities either. Most companies do have a website (60-80%), but only 40% uses social media and only 33% does have a marketing strategy.

From the workshop it was revealed that their positioning is not (always) clear: are they science or industry? This ambiguity, but also the fact that they offer new techniques not yet known to customers implies that potential clients need to do extra effort, e.g., a cost-benefit analysis to decide on buying the SSC-services. Instead, SSCs could provide proof-of-concepts as 'appetizers' to show what you can do with a (new) technique at a synchrotron.

2.2.2 Ecosystem

The second potential barrier refers to the ecosystem, more specifically the dynamics in the system: at the start the SSC has a clear selling point: its expertise with a new instrument and/or new technique. But as technology develops fast, it will be difficult to maintain this position. In addition, the thresholds for new entrants are low: SSCs make use of the instruments at light sources and other research infrastructures and don't need large capital investments. Most SSCs are well-embedded and work with many other partners, but if they don't develop (while others will), there is the risk that they will fall back into a secondary position of just servicing research infrastructures or other SSCs. As one of the workshop participants stated: *"If you lose uniqueness and you stay small, then you hardly have a future as SSC"*.

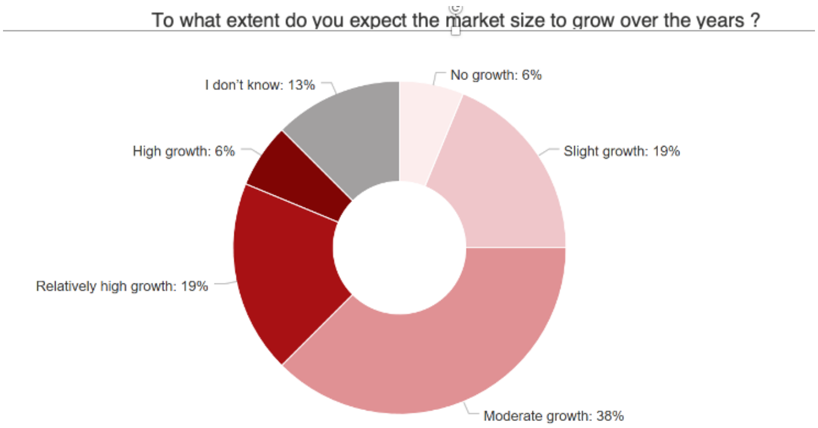
From interviews with SKF and EIRMA we can see a plea for better connecting EC and national initiatives with SSCs. Some good examples are the Italian thematic Competence Centres that are between universities and RIs, the Swedish VINNOVA programme (https://www.vinnova.se/en/), and perhaps also a connection to EC-initiated EOSC-platform (www.eosc-portal.eu, see next section).

2.2.3 Market

The market is a positive element: from both the survey and the workshop the signals are that SSCs are positive on market growth and business opportunities.

From the survey it reveals that 25% envisages (relatively) high growth, and almost 40% expects moderate growth.

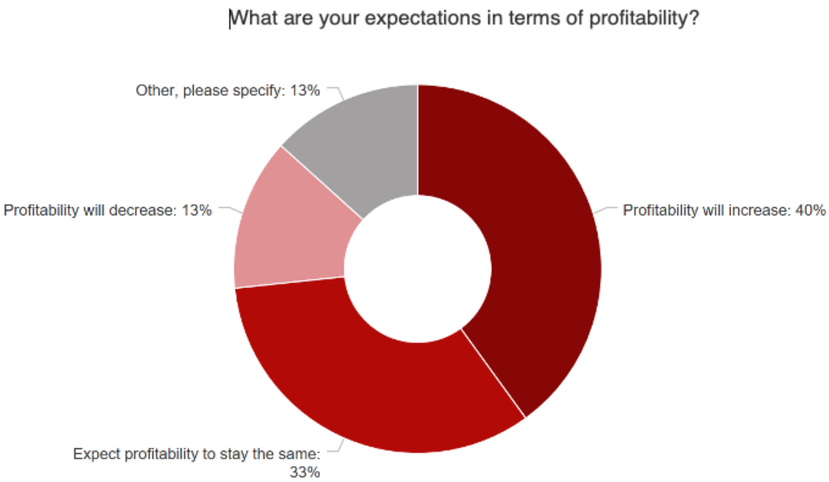
Figure 1 Survey question on market growth



CAROTS survey, 2021

SSCs are also positive on their profitability (in this growing market): 40% expects increase and only 13% expects a decrease in profitability.

Figure 2 Survey question on profitability



CAROTS survey, 2021

2.2.4 Other results

Most barriers for SME's, mentioned by the ECB study were not confirmed:

- SSCs have a good network to find customers (although we concluded that customers might have problems in determining the value proposition).
- SSCs can hire highly skilled staff, although it is difficult to pay competitive wages and to keep staff.
- Regulation and competition (and the market development) were not mentioned as barriers. As stated in the previous section, SSCs are positive about market growth and their profitability.
- Access to finance was mentioned, and most SSCs made use of public financial support. However, financial support is not so much need at the start, but would be welcomed when SSCs grow fast, (the companies need to upscale and deal with bigger contracts), and when new techniques or

instruments at the light sources become available. One suggestion was to provide (financial) support to get acquainted with new techniques. This relates to our 'Ecosystem & Dynamics' issue: SSCs want (and need) support to stay at the forefront of technology.

2.2.5 Conclusions

From the survey, the workshop, and the meetings with the client, we conclude that visibility and findability are low, and that marketing plans or strategies are not present. One reason could be that the SSCs are small and that they don't need a large customer base. But most SSCs in the survey are start-ups and younger than 5 years. The risk is in the development: as the SSCs mature they risk losing their unique position (related to a new technique). Hence, they should mature, grow, and stay in the vanguard of technological developments. This requires a professionalisation process with branding, expanding the customer base, and developing skills.

3 Market analysis & interviews

3.1 Objectives and scope

Scientific Service Companies (SSCs) are companies undertaking research for others and as such they bridge the gap between science and industry, accelerate the pace of technological change and help effectively use public research infrastructures. Although yet few SSCs exist in Europe in a pure form, there is a high potential for additional enterprises of this type, and it is important to understand their nature and improve conditions for the market to grow.

The objective of this study is to add to previous CAROTS studies and understand the role of Scientific Service Companies (SSCs), the dynamics in the context of their interactions with Research Infrastructures (RIs) and the potential for creating new ones.

3.1.1 Defining SSCs

SSCs have emerged a long time ago but there are difficulties in defining, identifying, and classifying them, because there is no universal definition or description. Companies undertaking such activities are encountered under different names and organisational forms, hence detecting them at the European (let alone global) scale is a challenge.

Since there is no directory of SSCs we searched the literature and the web and came up with the following sources for defining their activities:

- The recently formed CAROs network[4], which includes for profit companies that give targeted support and advice to companies that need research and measurement services in evolving fields, such as new materials, nanotechnology, and life sciences. In particular, the MIXN network formed through the CAROTS project is connecting industry to X-rays and neutrons[5].
- Contract Research Organisations (CROs), which are defined as undertaking research services outsourced on a contract basis and are not always for-profit organisations.
- The US Bureau of Labor Statistics defines the sector as the Professional, Scientific, and Technical Services sector comprises establishments that specialize in performing professional, scientific, and technical activities for others NAICS 54, specifically Scientific Research and Development Services coded NAICS 54176. This industry group comprises establishments engaged in conducting original investigation undertaken on a systematic basis to gain new knowledge (research) and/or the application of research findings or other scientific knowledge for the creation of new or significantly improved products or processes (experimental development). Techniques may include modelling and simulation[7].

3.1.2 Focus on New Materials

We used **New Materials** as a case to understand at least one segment of the market in deep, and which may be used as a pilot to expand to other sectors. The choice for this sector is twofold: new materials is a fast-growing sector (whereas pharmaceuticals is large but also mature), and it remains close to applications and analyses at light sources to which SSCs are currently connected. To scrutinize them we carried out desk research and conducted interviews with one SSC and four people working in Research Infrastructures to understand the main issues from both sides. Although we focus on using the case of New Materials, the resulting conclusions are generic, and recommendations may be applicable in areas beyond New Materials.

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4 https://www.carots.eu/

5 https://mixn.org/

6 https://www.bls.gov/iag/tgs/iag54.htm

7 https://www.naics.com/naics-code-description/?code=5417

3.2 Analysis of the development of existing SSCs

3.2.1 Methodology for identifying SSCs

There is nowhere a formal definition or a systematic registration of SSCs. A Google definition suggests “Service science, management, and engineering (SSME) is a term introduced by IBM to describe an interdisciplinary approach to the study and innovation of service systems. More precisely, SSME has been defined as the application of science, management, and engineering disciplines to tasks that one organization beneficially performs for and with another”[8].

Specialised Scientific Service Companies act as innovative problem solvers and facilitate applicable tailor-made solutions to industrial and societal challenges involving industry and academia. *Lowering the burden for businesses (particularly SMEs) to get in touch with research infrastructures and being knowledgeable about research instruments and methods are key features of their competence*. They meet industry’s interests in confidentiality and in concluding straightforward contracts on industry terms while advancing applied science through method development as well as real knowledge and technology transfer. They act as executors of scientific expertise and ”ambassadors” for research potential and facilities by e.g. carrying out measurements and experiments with their own staff at research facilities; they act as translators and educators of methods, results and data by interpreting scientific insights for their industrial customers; through all this, they act as accelerators for innovation by providing businesses with much quicker yet complete assistance in (analytical) research through targeted and nuanced application of conventional and advanced characterisation of e.g. ingredients or materials and speed up research and development in areas like infection research, life and material science (CAROTS, 2020).

Since SSCs appear under different names we used the following sources for our research:

1. *Commercial Analytical Research Organisations*[9] (CAROs), developed as a notion for a recent EU-funded Interreg project: A CARO is a profit-seeking organisation acting as an intermediary between research infrastructures and industrial customers, providing support, consultation, analytical research and measurement services in the field of new materials/ material sciences (including engineering), Life Science/BioTech, NanoTech and CleanTech on a contractual basis”. An addition to the original definition was necessary for highlighting the fact that these companies are private and for-profit. CAROs are divided in two categories, Core and Secondary CAROs, depending on whether they meet all the criteria of the revised definition or not accordingly. Secondary CAROs may be non-profit companies or companies that are not private[10].
2. *Contract Research Organisations* (CRO) have existed since the 1930s and are of various sizes, offer a variety of services, and are present worldwide[11]. They undertake research services outsourced on a contract basis and are not always for-profit organisations. All evidence suggests that CROs operate primarily in the health sector: A CRO is defined formally as “a company hired by another company or research centre to take over certain parts of running a clinical trial[12]”. The company may design, manage, and monitor the trial, and analyse the results. According to Wikipedia “a CRO is a company that provides support to the pharmaceutical, biotechnology, and medical device industries in the form of research services outsourced on a contract basis. A CRO may provide such services as biopharmaceutical development, biologic assay development, commercialization, preclinical research, clinical research, clinical trials management, and pharmacovigilance. CROs are *designed to reduce costs for companies developing new medicines and drugs in niche markets*. They aim to simplify entry into drug markets, and simplify development, as the need for large pharmaceutical

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[8] https://en.wikipedia.org/wiki/Service_science,_management_and_engineering

[9] https://projects.interreg-baltic.eu/projects/carots-196.html

[10] CARO market analysis

[11] https://www.sciencedirect.com/topics/pharmacology-toxicology-and-pharmaceutical-science/contract-research-organization

[12] https://www.cancer.gov/publications/dictionaries/cancer-terms/def/contract-research-organization

companies to do everything 'in house' is now redundant[13]". CROs are involved in all stages of the research process: recruitment, testing, data collection, and reporting to the industry. It is estimated that there are now more than 1,000 CROs with collective sales up to USD20 billion (ten Have et al., 2021).

3. Research and Technology Organisations (RTOs) defined by the European Association for RTOs (EARTO) as non-profit organisations which aim to "harness science and technology in the service of innovation, to improve quality of life and build economic competitiveness with high impact for society." [14]. Their technologies cover all scientific fields and their work ranges from basic research to the development of new products and services. For achieving this, RTOs collaborate with industries and a large number of public actors. Another definition for RTOs is the following: "RTOs are distinctive, mission-oriented R&D organisations which perform key functions in European innovation systems, and which exhibit characteristic strengths." EURAB (2005)[15]. We were aware that most RTOs are non-profit, hence do not comply with our definition of SSCs. Yet, looking at their activities was helpful for understanding the nature of the bridging activities and they also constitute a source from which profit-oriented enterprises may spin out.

An interview with the EIT KIC Raw materials was conducted to see whether SSCs are active in this area. We concluded that, although KIC Raw Materials has a high interest in new materials used to substitute metals and minerals there is no specific experience with SSCs. Through funding calls the KIC supports consortia to develop substitution materials from TRL5 to TRL7 at least with commercialization prospects, yet the members of the consortia are not scrutinized to identify their identities but their technological merits and roles in the consortia applying.

We ended up with a total list of 27 CAROs, 90 Secondary CAROs[16], 225 CROs (of which we used a sample of 70) and 40 RTOs (from the total of 42 2 were also listed as CAROs hence were not researched twice). From this total list of 484 potential candidates, we searched 227, then we filtered out those that are somehow related/interested in new materials based on two sources: the description in their sites and their description in LinkedIn.

3.2.2 New, advanced materials

In the literature New Materials and Advanced Materials are used as synonyms. An advanced material can be defined as any new or significantly improved material that provides a distinct advantage in (physical or functional) performance when compared to conventional materials[17] .

Advanced materials are those developed over the past years or so, that exhibit greater strength, higher strength density ratios, greater hardness, and/or one or more superior thermal, electrical, optical, or chemical properties when compared with traditional materials. Riggs (1988)[18] defines advanced materials as "materials with unique mechanical, thermal, optical, electrical, or magnetic properties, and combinations of these, purchased for function and for added value derived from use". Still, the term

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[13] https://en.wikipedia.org/wiki/Contract_research_organization

[14] https://www.earto.eu/about-rtos/

[15] European Research Advisory Board (EURAB) Final Report, Research and Technology Organisations (RTOs) and ERA: https://ec.europa.eu/research/eurab/pdf/eurab_05_037_wg4fr_dec2005_en.pdf

[16] In fact they are 104 but 14 have the label of both primary and secondary so we did not search again.

[17] https://www.prima.ca/en/advanced-materials/definition-of-advanced-materials/

[18] Riggs, J. P. (1988). "Developing Trends and Characteristics of High Performance Polymers and Composites: Manufacture, Supply, and Use," in Advanced Materials in the Manufacturing Revolution, ANL-89/3, CONF-8806303, Argonne National Laboratory, Argonne, as cited in Curlee, TR, Das, S., Lee, R. and Trumble, D. (1990) Advanced Materials: Information and Analysis Needs.

advanced material lacks a consensus definition and associated categorization or grouping system for risk screening[19].

Fraser et al. (1988,)[20] goes on to identify six advanced material subgroups:

- "Metals and alloys" such as aluminum-lithium alloys, amorphous and shape memory alloys, rapidly solidified and porosity metals and ordered intermetallics;
- "Structural ceramics" such as alumina, silicon carbide and nitride, beryllia, boron nitride, titanium carbide, and thoria;
- "Engineering polymers" such as polyacrylate, polyetheretherketone (PEEK), polyphenylene sulphide (PPS), and a variety of polyamide-imides;
- "Advanced composites" using metal, ceramic, or polymer matrix containing particle, whisker and fiber reinforcements made of such things as carbon, boron, zirconia, aluminum silicates, and polymers;
- "Electronic, magnetic, and optical materials" such as gallium, indium, yttrium, zirconium, barium, lanthanum and the lanthanides; and
- "Medical and dental materials" such as alumina and calcium phosphate glasses and carbon fibre reinforced polylactic acid composites.

Future materials developments will involve integration of “new” and “old” materials with increasing precision and sophistication, even at the nanoscale, and examples include materials for drug delivery, functional coatings, materials for solar power and energy storage devices[21].

The research to identify a list of SSCs in New Materials was based on checking a sample of the groups mentioned above as follows:

- All primary and secondary CAROs are included, characterised by their specialisation (using the following five categories: R&D, Consulting, Measurements, Marketing and Sales, Labs Testing and Engineering), field of activity (distinguishing between Multidisciplinary, Circular Economy, Pharmaceuticals, Diagnostics, Engineering, NanoTech, BioTech and CleanTech) and NACE codes. Companies specialising in new materials were singled out after visiting each company’s website and adding in our table a column with a briefing in services provided.
- A list of 225 CROs was found combining companies reported by Sofpromed[22], a CRO specialized in the global management of phase I-IV clinical trials and Meso Scale Discovery website[23] a global leader in the development, manufacture, and commercialisation of innovative assays and instruments for the measurement of molecules in biological samples. We visited each company’s website and added in our table a column with a briefing in these companies. The next step is to identify these companies that maybe are useful to include in our case study. We distinguished between Profit vs Non-profit and used again their description on their websites and LinkedIn.
- We also tried to identify possible Research and Technology Organisations (RTOs), extracted by EARTO. EARTO promotes RTOs and represents their interests in Europe and identified 16 which are, however, not for-profit.

The result is that out of 27 CAROs 7 are potentially working with new materials, out of 90 secondary CAROs there are 18 working in new materials and only 2 of the CROs in our sample. This very low share may be explained by the nature of most CROs being in biotech and pharma and working in clinical trials.

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[19] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6675647/

[20] Fraser, S., Barsotti, A. and Rogich, D. (1988). "Sorting Out Materials Issues," *Resources Policy*, 14(1), pp. 3-20.as cited in Curlee et al., 1990 Advanced Materials: Information and Analysis Needs.

[21] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/283886/ep10-new-and-advanced-materials.pdf

[22] https://www.sofpromed.com/

[23] https://www.mesoscale.com/

It may be that if we go into a more detailed analysis of their projects secondary activities in new materials could emerge. Conversely, in the case of RTOs 40% of EARTO members are in materials research.

Table 2 Total list of SSCs and non-profit intermediaries identified

Total list identified	CAROs (total 27)	Secondary CAROs (90=104-14 searched as primary)	CROs (total list 225)	RTOs (total list EARTO 42)	Total
Searched (in brackets remaining number to search)	27 (5 companies not found)	90 (8 companies not found)	Sample of 70 searched (155)	40 (2 common with CAROs)	227
Not in new materials	20	72	68	24	185
Identified as working with new materials	7	18	2	16	42

3.2.3 *Scientific service provision organisations in new materials*

Based on the data collected by CAROs Market Analysis, LinkedIn, Crunchbase and organisations' website we made an analysis and crossed data for reaching to some conclusions. We first distinguish the SSCs between for-profit and non-profit organisations. For-profit organisations will be analysed here as they are SSCs while non-profit organisations will be analysed in the next section because they are not real SSCs, but we may learn from their activities.

The table below presents the type of SSCs per country. There is one Polish organisation which offers services both commercially as well as non-commercially, therefore it is studied under one category only and we go from a total of 42 on Table 2 to 41 on Table 3. It is also interesting that in our research one CARO appears as non-profit whereas CAROs are supposed to be profit oriented.

Table 3 SSCs distinguish between for profit and non-profit per country

	For profit					Non-profit					
SSCs Country	**Core CAROs**	**CROs**	**RTOs**	**Secondary CAROs**	**Total for profit**	**Core CAROs**	**CROs**	**RTOs**	**Secondary CAROs**	**Total non-profit**	**All**
Austria	1				1			3		3	**4**
Denmark						1				1	**1**
Estonia	1				1						**1**
Finland				1	1						**1**
France				2	2						**2**
Germany				6	6			1		1	**7**
Greece	1				1						**1**
Italy								1		1	**1**
Japan		1			1			1		1	**2**
Latvia	1				1						**1**
Netherlands				2	2			1		1	**3**
Norway								1		1	**1**
Poland				2	2						**2**
Romania				1	1						**1**
Singapore								1		1	**1**
Slovenia								1		1	**1**
Spain								3	1	4	**4**
Sweden				1	1			1		1	**2**
Switzerland	1				1						**1**
UK				2	2			1		1	**3**
United States		1			1						**1**
Total	**5**	**2**		**17**	**24**	**1**		**15**	**1**	**17**	**41**

Looking at the countries where SSCs are created we see that:

1. In the EU the EU-15 has an overwhelming majority of SSCs. Germany is the country with 7, the most SSCs working with new materials, followed by Austria and Spain with 4 each, then UK, Poland, and the Netherlands with 3, and France, Sweden and Japan with 2.
2. Central and Eastern Europe and Southern Europe, where Spain plays a key role, have more non-profit intermediaries than SSCs in its strict definition. Non-European countries number 7 organisations, 4 for-profit and 3 non-profit.

The size of the companies in terms of employment could only be found for 24 companies, showing clearly a majority of them being medium sized:

Table 4 Number of employees per for profit SSCs - Industry

Number of employees	**2-10**	**11-50**	**51-200**	**201-500**	**501-1000**	**1001-5000**	**Null**	**Total**
SSCs - Industry								
Core CARO	**2**	**1**	**1**				**1**	**5**
Mechanical Or Industrial Engineering	1							1
Research		1	1					2
Null	1						1	2
CRO			**1**			**1**		**2**
Biotechnology			1					1
Chemicals						1		1
Secondary CARO	**1**	**9**	**4**	**2**			**1**	**17**
Automotive				1				1
Biotechnology			1					1
Chemicals		3						3
Civil Engineering				1				1
Mechanical Or Industrial Engineering		1						1
Mining & Metals			1					1
Nanotechnology	1	1	1					3
Oil & Energy		1						1
Pharmaceuticals		1						1
Research		1	1					2
Null (not identified)		1					1	2
Total	**3**	**10**	**6**	**2**		**1**	**2**	**24**

SSCs in a narrow sense (primary CAROs) are the smaller ones. In technological and sectoral terms, they are spread thinly across industries with chemicals and nanotech being the most frequently encountered.

Table 5 Number of employees per industry and country

Number of employees	2-10	11-50	51-200	201-500	501-1000	1000+	Null	Total
Industry's name - Country								
Automotive				**1**				**1**
Poland				1				1
Biotechnology			**2**					**2**
Sweden			1					1
United States			1					1
Chemicals		**3**				**1**		**4**
Germany		2						2
Japan						1		1
UK		1						1
Civil Engineering				**1**				**1**
Finland				1				1
Mechanical Or Industrial Engineering	**1**	**1**						**2**
Greece	1							1
Netherlands		1						1
Mining & Metals			**1**					**1**
Germany			1					1
Nanotechnology	**1**	**1**	**1**					**3**
Germany		1	1					2
Netherlands	1							1
Oil & Energy		**1**						**1**
UK		1						1
Pharmaceuticals		**1**						**1**
France		1						1
Research		**2**	**2**					**4**
Austria		1						1
France		1						1
Latvia			1					1
Poland			1					1
Null	**1**	**1**					**2**	**4**
Estonia							1	1
Germany		1						1
Romania							1	1
Switzerland	1							1
Total	**3**	**10**	**6**	**2**		**1**	**2**	**24**

In Germany SSCs are spread across sectors, namely Chemical, Mining & Metals and Nanotechnology, followed by France in Pharmaceuticals and Research, Netherlands in Mechanical or Industrial Engineering and Nanotechnology, Poland in Automotive and Research and UK in Chemicals and Oil & Energy. As far as the for-profit organisations are concerned Chemicals is the sector with the most employees 1001-5000 in Japan, followed by Automotive with 201-500 employees in Poland and Civil Engineering with 201-500 employees in Finland.

Table 6 Number of employees per NACE

Number of employees	2-10	11-50	51-200	201-500	Null	Total
NACE						
Agents specialised in the sale of other particular products - 4618			1			1
Computer programming activities - 6201			1			1
Engineering activities and related technical consultancy - 7112	1	2		1		4
Manufacture of other chemical products n.e.c. - 2059		1				1
Manufacture of plastics in primary forms - 2016					1	1
Other professional, scientific and technical activities n.e.c. - 7490		1				1
Other research and experimental development on natural sciences and engineering - 7219		2	3	1		6
Research and experimental development on natural sciences and engineering - 7210		1				1
Technical testing and analysis - 7120		2				2
Total	**1**	**9**	**5**	**2**	**1**	**18**

NACE codes are only available for secondary CAROs. NACE codes with the most employees are "Other research and experimental development on natural sciences and engineering" and "Engineering activities and related technical consultancy" with 201-500 employees. These two NACE codes form the majority of the secondary CAROs.

Table 7 NACE and Industry by country

Country	FIN	FRA	GER	NL	POL	ROM	SPA	SWE	UK	Total
NACE - Industry										
Agents specialised in the sale of other particular products			**1**							**1**
Nanotechnology			1							1
Computer programming activities								**1**		**1**
Biotechnology								1		1
Engineering activities and related technical consultancy	**1**	**1**	**1**	**1**						**4**
Civil Engineering	1									1
Nanotechnology				1						1
Research		1								1
Null			1							1
Manufacture of other chemical products n.e.c.									**1**	**1**
Chemicals									1	1
Manufacture of plastics in primary forms						**1**				**1**
Null						1				1
Other professional, scientific and technical activities n.e.c.									**1**	**1**
Oil & Energy									1	1
Other research and experimental development on natural sciences and engineering			**2**	**1**	**2**		**1**			**6**
Automotive					1					1
Mechanical Or Industrial Engineering				1						1
Mining & Metals			1							1
Nanotechnology			1							1
Plastics							1			1

Research					1					1
Research and experimental development on natural sciences and engineering			**1**							**1**
Chemicals			1							1
Technical testing and analysis		**1**	**1**							**2**
Chemicals			1							1
Pharmaceuticals		1								1
Total	**1**	**2**	**6**	**2**	**2**	**1**	**1**	**1**	**2**	**18**

Secondary CAROs economic activities, as referred in CAROTS Market Analysis, are mainly in “Other research and experimental development on natural sciences and engineering” (6 CAROs), in ”Engineering activities and related technical consultancy” (4 CAROs) and in “Technical testing and analysis” (2 CAROs).

By crossing the sources of LinkedIn and CAROTS Market Analysis we found that the NACE “Other research and experimental development on natural sciences and engineering” is referring to Automotive, Mechanical or Industrial Engineering, Mining & Metals, Nanotechnology, Plastics and Research while NACE “Engineering activities and related technical consultancy” is referring to Civil Engineering, Nanotechnology and Research.

Other economic activities of the secondary CAROs are: “Agents specialised in the sale of other particular products”, “Computer programming activities”, “Manufacture of other chemical products n.e.c.”, “Manufacture of plastics in primary forms”, “Other professional, scientific and technical activities n.e.c.” and “Research and experimental development on natural sciences and engineering”.

Table 8 SSCs and Industry by foundation decade

Foundation decade	**1950-1959**	**1960-1969**	**1970-1979**	**1980-1989**	**1990-1999**	**2000-2009**	**2010-2019**	**Null**	**Total**
SSCs - Industry									
Core CAROs						**1**	**3**	**1**	**5**
Mechanical Or Industrial Engineering							1		1
Research						1	1		2
Null							1	1	2
CROs			**1**			**1**			**2**
Biotechnology						1			1
Chemicals			1						1
Secondary CAROs	**1**		**1**	**1**	**4**	**7**	**3**		**17**
Automotive			1						1
Biotechnology						1			1
Chemicals					1	1	1		3
Civil Engineering	1								1
Mechanical Or Industrial Engineering						1			1
Mining & Metals							1		1
Nanotechnology					2	1			3
Oil & Energy						1			1
Pharmaceuticals					1				1
Research						1	1		2
Null				1		1			2
Total	**1**		**2**	**1**	**4**	**9**	**6**	**1**	**24**

As expected, most of the for-profit organisations were founded in the 21st century, with four established in the 1990s' and four more between 1950-1990. Following LinkedIn classification of the organisations per industry type, core CAROs involve Mechanical or Industrial Engineering and Research, CROs involve Biotechnology and Chemicals, and secondary CAROs involve Automotive, Biotechnology, Chemicals, Civil Engineering, Mechanical or Industrial Engineering, Mining & Metals, Nanotechnology, Oil & Energy, Pharmaceuticals and Research.

Research and Chemicals are the two industries with the most organisations (4 each), followed by Nanotechnology (3 organisations) and Mechanical or Industrial Engineering and Biotechnology (2 each).

3.2.4 Analysis of the development of similar services on the market

Scientific services are increasingly both sought after and offered. The market is covered by a wide range of intermediaries, which, beside the SSCs presented above include:

- Technology Transfer Offices in RI and Universities, created as a response to governments request to expand the publicly funded research laboratories to ensure the economic benefit of the investments. The TTOs, which started with large success stories in the most technologically advanced US universities range from large offices promoting research results and research facilities with dedicated and specialised personnel to very small units with 1-2 employees focusing more on supporting research personnel in the RI and less on advising/promoting the use of the laboratories.
- Industrial Liaison Offices are created in many organisations to ensure information is available and Information Contact Officers (ICOs) connect with industry as potential users of facilities, services and research results. Although the size and specialisation of ILOs differ, they can play an active role in organising and spreading the information that can be used for scientific service provision.
- RTOs are in principle non-profit organisations with public missions to support society. To do so, they closely cooperate with industries, large and small, as well as a wide array of public actors.
- Independent publicly funded intermediaries, such as cluster organisations and support for ecosystem development.

Hence, there is **strong competition** in the market, regarding scientific services to companies and SSCs need to ensure their added value to survive and flourish.

However, the most active among them who have already an established reputation and clientele might consider the possibility to spin out from their secure environment and act as SSCs. The Swiss Light Source (SLS) is a synchrotron located at the Paul Scherrer Institute (PSI) in Switzerland for producing electromagnetic radiation of high brightness[24] has span out its industrial liaison activities in a profit-oriented company. This spurs an interesting discussion on what is the difference between ILO/TT activities being internal to a RI or being operated through RI-owned independent companies. One may argue that what differs are the profit / cost centres since it is the same employer and the same recipient of revenues at the end of the day. Yet, the business model is completely different, since the spin out is (or may in the future be) expanding its services beyond the home organisations and become a fully-fledged SSC transferring its profits to a RI.

[24] https://www.psi.ch/en/sls

Table 9 Number of employees per non-profit organisation

Organisation's type / Number of employees	Core CAROs	RTO	Secondary CAROs	Total
2-10				
11-50		1		1
51-200		1	1	2
201-500		4		4
501-1000		1		1
1001-5000	1	6		7
5001-10000		1		1
10001+		1		1
Null				
Total	**1**	**15**	**1**	**17**

RTOs have a large number of employees as they start from 11-50 employees and reach over the 10.000, 6 of them appear to have 1001-5000 employees while 4 of them 201-500 employees. In contrast to the for profit core CAROs which have few employees, the non-profit core CARO have 1001-5000 employees while the non-profit secondary CARO is still at the same level as the for profit secondary CAROS. For profit SSCs have less employees in contrast to RTOs where lots of researchers are needed.

Table 10 Number of employees per industry and country

Number of employees	11-50	51-200	201-500	501-1000	1001-5000	5001-10000	10001+	Total
Industry - Country								
Information Technology & Services					**1**			**1**
Denmark					1			1
Plastics		**1**						**1**
Spain		1						1
Research	**1**	**1**	**4**	**1**	**6**	**1**	**1**	**15**
Austria	1		1		1			3
Germany							1	1
Italy		1						1
Japan					1			1
Netherlands					1			1
Norway			1					1
Singapore						1		1
Slovenia			1					1
Spain			1	1	1			3
Sweden					1			1
UK					1			1
Total	**1**	**2**	**4**	**1**	**7**	**1**	**1**	**17**

Non-profit organisations are mainly RTOs, followed by one core CARO and one secondary CARO in Information Technology & Services and Plastics respectively. Germany and Singapore are the countries with organisations that exceed 5000 employees. RTOs have a large number of employees available for research.

Table 11 Non-profits by foundation decade

Industry	Core CAROs Information Technology & Services	RTOs Research	Secondary CAROs Plastics	Total
Foundation year				
1900-1909	1	1		2
1910-1919				
1920-1929		1		1
1930-1939		1		1
1940-1949		1		1
1950-1959				
1960-1969				
1970-1979		1		1
1980-1989				
1990-1999		2	1	3
2000-2009		5		5
2010-2019		3		3
Total	**1**	**15**	**1**	**17**

SSCs constitute a recently growing type of companies, concentrated but not exclusively in technologically advanced countries, their majority not undertaking Scientific Services exclusively but coupling it with internal use of their knowledge, only the smaller ones being SSCs in a strict sense. The use of their services is spread across a wide range of industrial sectors and technologies.

Based on the tables created by crossing information for the selected organisations we conclude that:

- Germany is the country with the most SSCs working with new materials (7 organisations) which includes industries such as Chemical, Mining & Metals and Nanotechnology.
- Secondary CARO are mainly focused on NACE "Other research and experimental development on natural sciences and engineering", which is referring to Automotive, Mechanical or Industrial Engineering, Mining & Metals, Nanotechnology, Plastics and Research and "Engineering activities and related technical consultancy", which is referring to Civil Engineering, Nanotechnology and Research.
- As far as the for-profit organisations are concerned Chemicals is the sector with the most employees 1001-5000 in Japan, followed by Automotive with 201-500 employees in Poland and Civil Engineering with 201-500 employees in Finland.
- For-profit SSCs have less employees in contrast to RTOs where lots of researchers are needed.
- Research and Chemicals are the 2 industry types with the most organisations (4 each), followed by Nanotechnology (3 organisations) and Mechanical or Industrial Engineering and Biotechnology (2 each).
- For profit organisations founded after 90's with a peak at 00's while non-profit organisations dated back in 1900's with a peak at 00's too.

3.3 Estimation of the future development of the market for scientific services

The market drivers for new, advanced materials include: the increase in the relative cost in energy; the requirements of the micro-electronic components industry; the specific demands generated by the use of micro-electronics in new products and processes and the requirements of the health sector. Areas of application are practically all modern industries: Energy (batteries), Transportation (airplane fuselage, car industry in particular electric vehicles), Environment (recycling qualities, desalination), Health (drug delivery, bio-derived materials, substitution implants), Advanced manufacturing (robotics), construction (engineered wood), ICT (cell phone components), Textiles (smart clothing), Packaging, Defence Security (armour) [25].

Because of their nature and sectoral needs the market for new, advanced materials is expected to grow very rapidly:

- **Lightweight materials** There have been sustained efforts since the 1970's oil crises to reduce weight in transport systems to realise improved energy efficiency. Aluminium and magnesium alloys, carbon and glass fibre reinforced epoxy composites, and metallic and composite foams currently used only in niche, high value vehicles will increasingly find applications in high volume car manufacture. Future airframes will comprise therefore highly optimised and intricate mixtures of aluminium alloys and composite materials, in hybrid materials systems along with titanium alloys. Smart textiles research is at the earliest stage and concerns materials that function as textiles but have additional functionalities such as extreme hydrophobicity, sensing, actuation, energy harvesting and storage, data storage, and communication (Jost et al., 2011). Examples of potential applications of this technology include military garment devices, biomedical and antimicrobial textiles, and personal electronics. Although smart textiles might be considered new, discrete materials, they are hybridised materials at the micro- or nanoscale in which the incremental nature of the manufacturing processing e.g., weaving allows incorporation of additional materials and devices into the finished product.
- ***Replacement of materials*** which have been deemed harmful to the environment or hazardous to health under directives such as the European Union Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) legislation (European Union, 2006, Regulation (EC) No. 1907/2006) creates opportunities for new materials.
- ***Bio-derived materials*** In the last 10 years we have seen an order of magnitude increase in the number of scientific publications concerned with biocomposites, with a huge diversification of potential biofeedstocks providing the matrix and the fibre. The automotive sector presents possibly the greatest opportunities for biocomposites, offering massive volumes to retrieve economies of scale, and where carbon fibre supply cannot meet forecast need. The construction sector also offers significant market opportunities for structural applications in relatively lightly loaded sections, especially those under compression. To meet these and other market needs, the next decades will require continued improvements in matrix and fibre property and reproducibility, design understanding (including interfacial design between fibre and matrix and integration of biocomposites into hybrid structures with conventional materials) and environmental stability (partly enabled by the use of coatings), especially fire resistance. Other opportunities include the use of genetic engineering of materials for bio-feedstocks to maximise the yield of useful constituents.

And we see high value markets in:

- ***Metamaterials*** are artificial materials with electromagnetic (EM) properties that are difficult or impossible to achieve with naturally occurring materials. Monolithic, isotropic materials with single valued permittivities and permeabilities at a given frequency, temperature, etc., are arranged in careful architectures that as an ensemble produce a material with contrived, unusual, or even negative values of permittivity, permeability and refractive index.
- ***Carbon nanomaterials, graphene and 2D nanomaterials*** Graphene is being suggested for an ever-widening range of applications, but most effort has focused on electronic applications: fast transistors and efficient emitters. Progress has been swift, but difficulties in market penetration stems from high cost and lack of scalability. In optical devices, graphene is likely to realise its long-recognised potential as a thin, transparent, and conductive films in touch screens, solar cells, and other applications replacing indium-tin-oxide due to the high cost of indium. Electrochemical energy storage (batteries, supercapacitors) where carbon is already used widely offers a good near-term market opportunity, and graphene's specific niche and advantage over the many other carbon

[25] https://www.prima.ca/en/advanced-materials/definition-of-advanced-materials/

polymorphs may emerge more compellingly. For structural applications, graphene has been shown to produce stiffening and strengthening effects in polymers, which has been argued to be superior to carbon nanotubes (CNTs) for similar loadings. Like CNTs, graphene additions at only low volume fraction simultaneously provide enhanced heat and electron transport.

- ***Biomaterials*** advances in replacement and transplant surgery have seen a huge increase in implantable medical devices in the last decade, with hip, knee and some spinal joints now being replaced on an almost routine basis. Nonetheless, enormous potential remains for the impact of novel materials in the biomedical and healthcare market. New materials are relevant for most research from the car industry to medical devices, pharma and laser technologies which use advanced materials for the arrangement of the means that create the radiation (usually optical fibres) but also for coating and surface alloying, leading the allow to change its properties and polymers, changing their morphology. Advanced ceramics, metals, and polymers, including composites of these, offer the promise of decreased energy consumption, better performance at lower cost, and less dependence on imports of strategic and critical materials[26]. Hence, a wide range of sectors and research areas address new materials[27].

In the presently emerging techno-economic paradigm, the role of new materials tends to be very different: no single material seems to be associated with the paradigm, but rather a kind of global dynamics in the conception and diffusion of a vast variety of homogeneous and heterogeneous materials.

This dynamic applies not just to "recent" high-performance materials such as composites, but equally to more "traditional" materials such as metallic alloys or ceramics. It is based on increasing knowledge of the microscopic properties of matter and on mastering industrial reproduction processes of these microscopic properties, enabling different materials to be combined to make new alloys or composites and to customize their properties.

The market for scientific services is very likely to expand in the future because:

1. ***Technological complexity*** increases and companies are unlikely to have internal expertise for more than their core competences, so they will need specialised STEM capabilities to help them. 3D printing, graphene, light materials are indicative cases.
2. The ***green transformation*** and the cyclical economy request significant changes in terms of building materials but also batteries and energy storage; new materials will be necessary and need to be tested before being integrated in the economy.
3. ***Equipment*** is becoming more sophisticated and expensive and only few organisations can afford it, but its amortisation needs a wider range of exploitation.
4. ***Specialised intermediaries*** can offer new ideas both for solving problems but also for new uses/markets for scientific equipment.
5. Both companies and RI may under certain circumstances prefer to use intermediaries because this helps them ***convert fixed into variable cost***.

Many of the SSC activities are offered directly by RIs, in particular larger ones, such as ERICs or other ESFRIs. The central organisation supports its legal entities. They undertake scientific services distinguishing themselves from SSCs by being not-for-profit (cf. the spin out in the SLS example).

RIs offer practically three types of cooperation agreements:

- Model 1: Buy time and let ***scientists*** from the business sector work in the RI facilities for a specific time or job cased on a contract concluded in advance.

[26] Curlee, TR, Das, S., Lee, R. and Trumble, D. (1990) Advanced Materials: Information and Analysis Needs.

[27] https://archive.unu.edu/unupress/unupbooks/uu09ue/uu09ue18.htm

- Model 2: Use ***in-house*** scientific services, whereby the RI invoices the business (client) directly, the contract again being concluded between the RI and the company.
- Model 3: Engage with an i***ntermediary*** (SSC; CRO). In this case the intermediary has a good knowledge and know how to use the RI service, both the industrial client and the RI trust the intermediary and there are two contracts concluded (or one tripartite).

In the first two cases costs and profits are split between two partners, whereas in the third there is one additional associate, the SSC needing to prove its value added to convince industry (the client) not to go directly to the RI and use Models 1 or 2, but also explain to the RI why an intermediary would be doing a better job than the TTO or ICO of the RI itself. One may think of the following cases where the intermediary adds value and Model 3 makes more sense than Models 1 and 2:

1. *VA for the company*: The company wishing to use the RI facilities does not have the expertise outside its core business to describe and organise the research. In this case an intermediary takes the role of formulating and not only implementing the project. For the company, in particular if it has a long-term relationship with the SSC working in different RIs, it saves the time to explain the problem. In this case the value added of the SSC is its knowledge in several niches.
2. *VA for the RI*: The research is done in an area of utilising RI facilities, which is either too small or too new to be of interest for the TTO/ICO to focus on (e.g., interpretation of three-dimensional data). In this case the value added of the SSC is a catalytic role for new markets.
3. *VA for new knowledge*: The interaction of SSCs with different clients may position the organisation in a place to identify emerging needs/trends shared by more clients and put together research proposals with both the clients and the RI.

SSC clients can be science (incl. the RIs) or businesses. In both cases SSCs need to offer special advantages if they wish to succeed (individually or as a type of activity) and convince their clients/suppliers to externalise rather than internalise the scientific service they need.

Science and business may prefer to operate without intermediaries, let alone profit-oriented intermediaries, with the aim to internalise revenues and knowledge. Hence, only if SSCs offer an excellent wage/productivity ratio will they survive.

Maybe the difficulty of attaining the necessary knowledge for that, as well as the competition from non-profit intermediaries, may be the reason behind their limited number. Yet, the increasing number of SSCs in the 21st century indicates that possibly modern tools allow SSCs to specialise and fulfil their role in competitive terms. To help build the competitive edge one needs to fully understand the models of cooperation:

A: With large research infrastructures (RIs) they have multiple channels of cooperation:

- *SSCs offer their services to RIs.* These services are always state-of-the-art and hence not only they create revenues, but the interaction helps SSCs remain technologically updated. CERN, light sources, and ESA are among the largest clients for SSCs and have created a network of incubators across Europe to support their SSCs; these incubators have different degrees of success. Similarly, the EIT has created RIS to help activate organisations in peripheral regions.
- *SSCs offer their services to business and use the facilities of RIs against payment*: While both parties are highly interested in developing this mode of collaboration there are several barriers: for one, streamline communication channels and facilitate accounting procedures which because of State Aid rules may be complex for publicly funded RIs when they serve profit-oriented businesses. This can constitute barriers for partners to seek cooperation. RIs differ in terms of organising their TT and their communication activities. have made a point in organise this system, whereas others are left behind.
- *SSCs and RIs join forces in common international, publicly funded projects*: These are cases where both parties have an interest and are the smoothest to develop. Yet, the number of applications is small, compared to the potential for cooperation, but common projects are a good way towards

getting to know each other's potential and interests and further develop into one of the two other links.

B: Relations with companies can be classified based on their nature and time horizon:

- *Incidental*: There are *market driven, ad hoc services* when a company requests specific scientific services; these are shorter contracts and unlikely to lead to longer term relationships or translate into trilateral relations between large companies, SSCs and RIs.
- *Joint, externally funded projects*: As with RIs *SSCs join forces with businesses in common projects (incl. international or publicly funded)*: These are cases where both parties have an interest and are the smoothest to develop. This applies a lot more to larger multinationals than SMEs. Yet, the number of applications is small, compared to the potential for cooperation, and contacts are established with specialised researchers /project managers from the side of the company, depriving the SSC from the potential to demonstrate its capabilities higher in the hierarchy and ensure longer term relationships.
- *Long-term relationships* allowing for SSCs and large enterprise to develop co-evolving projects and technologies. This leads to more services needed from RIs as well. However, this type of relationship is rarer than the two others.

3.3.1 New services on new markets

Current EC initiatives on Open Science address the issue on how to allow for a faster circulation of increasing amounts of knowledge and seize the potential of open innovation to trigger faster and fairer growth, building a knowledge economy that is open to the world"[28]. One of the ambitions of the EC is to realises the European Open Science Cloud (***EOSC***). This EC initiative, supported by the Member States and Associated Countries, federates existing European Research Infrastructures, offering access to RIs and the opportunity to compose new services from existing RI services, tools and data.

Although EOSC will start with science and public users, it will expand to commercial parties – both providers and users. The SSC-network could become a relevant partner in this EOSC because SSCs are the perfect 'in-between' science and industry. And SSCs could benefit from better and easier access to European RI facilities – not only storage, computing and networking, but also access to light sources and other physical RIs.

EOSC-related Horizon projects aim to better connect to SMEs to provide new services – to research, but later also to industry. SSCs can position themselves in providing new (data-driven and RI) services to science. These projects reach out to SMEs via calls on co-creation, business pilots and other instruments.

3.4 Reporting of results

The case of New, Advanced Materials is particularly attractive for SSCs which cover a real market need. At the same time, as the market need becomes more visible, they face competition from non-profit intermediaries and from larger RIs, ESFRI and ERICs developing scientific services in-house and offering them directly to the market.

SSCs are worth being approached and helped to grow if they can prove that they can offer value added to the services already provided by the RIs themselves. This can be done with various means:

- Matchmaking events of SSCs with Technical Managers from all Technical Departments of large, innovative multinationals to understand each other's needs and capabilities and be able to contact each other regularly and not only for common publicly funded projects. These events need to be carefully prepared, not engage in business discussions but really understand the future potential or each partner.

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[28] Lamy, LAB FAB APP, Investing in the European future we want, p.8

- Work systematically on clarity with respect to State Aid rules. The accounting difficulties have led only larger RIs to adopt the necessary processes to distinguish between services to profit-oriented and not-for-profit organisations. Facilitating the regulatory framework is important, but at the same time helping RIs to organise their information systems and make transparent and cost-competitive rules for SSCs will help interactions.
- Being brought early on in contact with start-ups and RI Spin Offs, which are a special group being too small and in need for more complementary technologies than larger companies.

Given the growth of the market, public policy may investigate ways to help ***create new SSCs***. This can be done by:

- Incentives to transform TTOs and Industrial Liaison Offices (ILOs) into profit-oriented companies serving not only the RI from where they spin out but explaining to other RIs as well.
- Support development of SSCs in specific thematic areas, e.g., Green Transition, Energy, the Wallenberg Wood Science Center[29] (new materials from trees). Keys are knowledge-driven products.

4 Analysis

SSCs are relatively new companies offering for-profit services to science and business. With their expertise and services, they are the perfect in-between, although for business it is often difficult to get clarity on the services that are offered by the SSCs. Next to this ambiguity on their value proposition, there is also lack of visibility, and it is difficult to stay at the forefront of technology to keep their unique position in the market.

Profitability and market opportunities are good – in 'traditional' sectors like pharmaceuticals, but also in emerging markets of new materials. A new market may also emerge via EOSC – to connect science and RIs and offering new services for researchers to facilitate use at large and complex RIs.

To strengthen the position and sustainability of SSCs, EC and Member States should initiate more thematic programmes (e.g., Competitive Centres IT, VINOVA programmes in SWE) and initiatives for creating a level-playing field in Europe, to support SSCs in less-developed Member States.

Platforms – both physical and digital – can help SSCs to improve visibility and findability or create synergies by networking, but also to create a single point of contact for EC, Member States, and other stakeholders. SSC staff and management need training and coaching to efficiently run the SSC operations, but also to develop strategies for attaining a strong(er) market position and remaining in the vanguard of technological developments. Existing platforms that could be strengthened are the Digital Innovation Hubs, EIRMA[30], the MIXN[31] network (connecting industry to X-rays and neutrons) and the SSC Start-up School.

The type of support might depend on the phase, e.g., the Start Up School and various (national) Start Up Grants for the first phase, financial support (EIRMA) during the fast growth phase. During all phases, SSCs could benefit more from networks and partnerships with other SSC's or Research Infrastructures.

To conclude, it is vital for all SSCs be innovative and to be able to develop new measurement methods and services – either by themselves or in cocreation with the RI or the industrial clients. This goes for all SSCs and remains important during all phases. Platforms can help to better connect and provide training and share expertise. Thematic programmes can help as well to discover new markets. To create level-playing fields in Europe and foster SSCs, both EC and national governments should invest in creating SSCs and provide (financial) instruments for keeping them in the vanguard of technology.

[29] https://wwsc.se/

[30] https://www.eirma.org/

[31] https://mixn.org/

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Appendix A Results from the survey

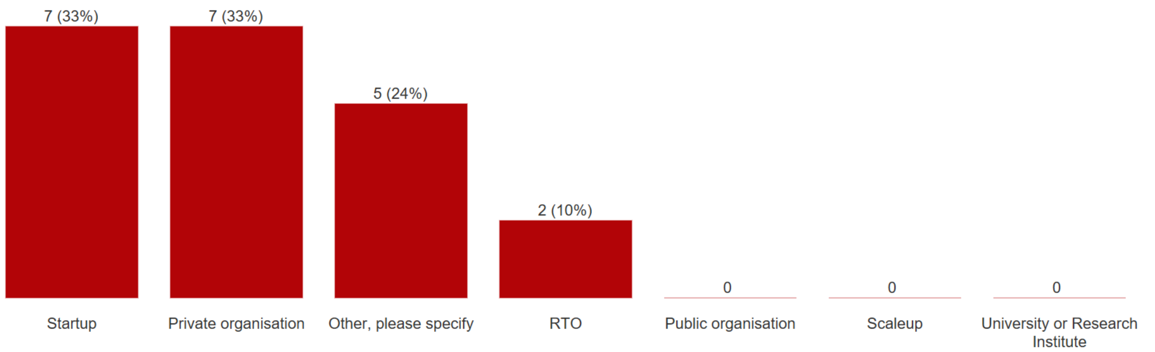
Typology

1. Response rate and confidentiality

	Count	% of responses	%
I give my consent to Technopolis Group to process my response to this questionnaire for the purposes of this study only	51		100%

N 51

2. Organisation type



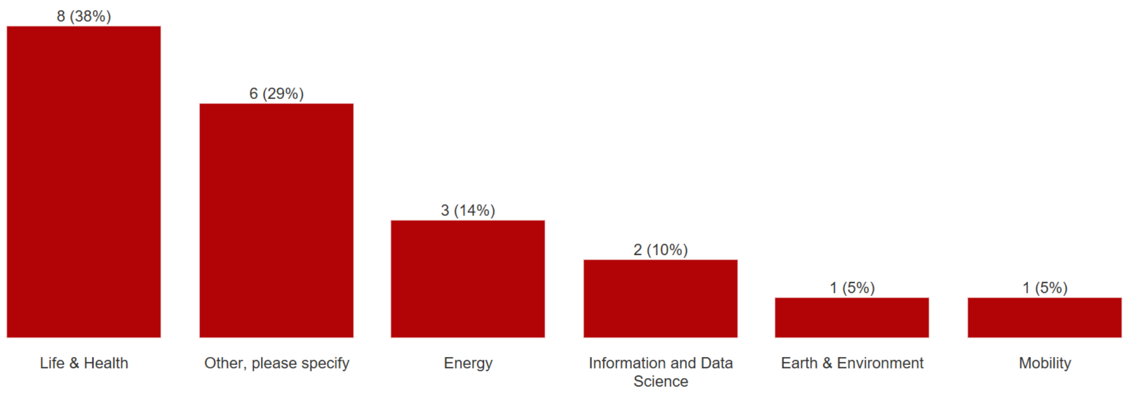
N 21

3. What are the main services by your organisation?

	Count	% of responses	%
Consulting	15		71%
Scientific services	15		71%
Testing	8		38%
Other, please specify	7		33%
Brokerage	3		14%

N 21

4. What is your main focus area?



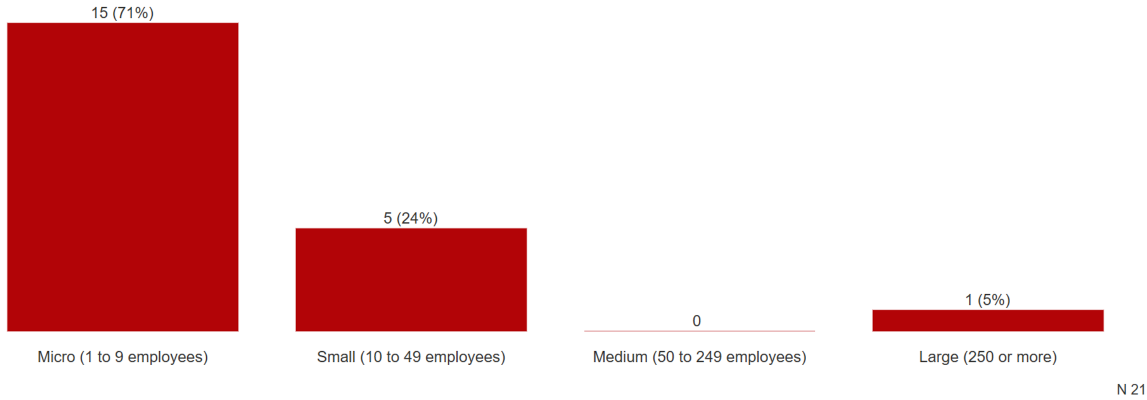
N 21

5. What technologies do you use?

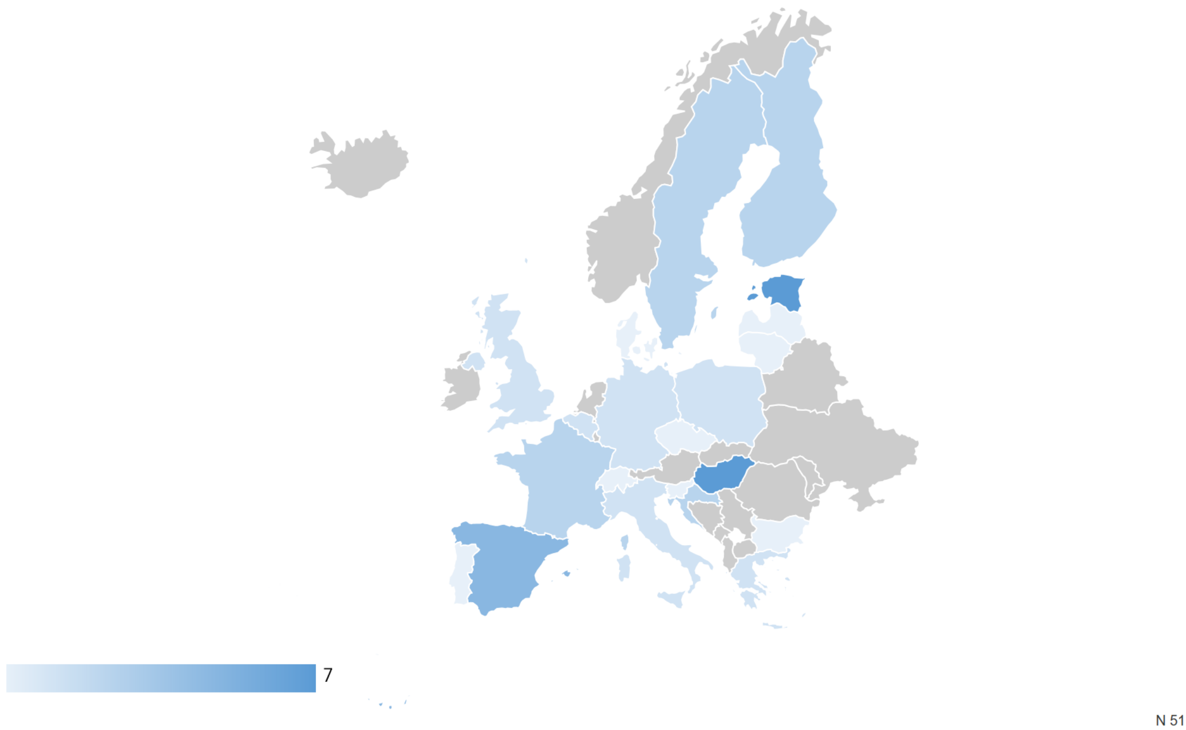
	Count	% of responses	%
Other, please specify	8		38%
Biomaterials	6		29%
Additive materials	5		24%
Energy storage	5		24%
Energy Conversion (e.g. Fuel cells, Hydrogen economy)	5		24%
User interfaces (including security aspects)	5		24%
1D and 2D materials	4		19%
Functional materials	4		19%
AI to analyze differences and similarities (e. g Image recognition)	3		14%
Digital medicine (e.g. detectors)	3		14%
Ultra light materials	3		14%
Human machine interaction	1		5%
Recycling	1		5%
Structure and function of proteins (e.g. RNA, drugs)	1		5%
Quantum computing	0		

N 21

6. Organisation size?



7. Country of origin



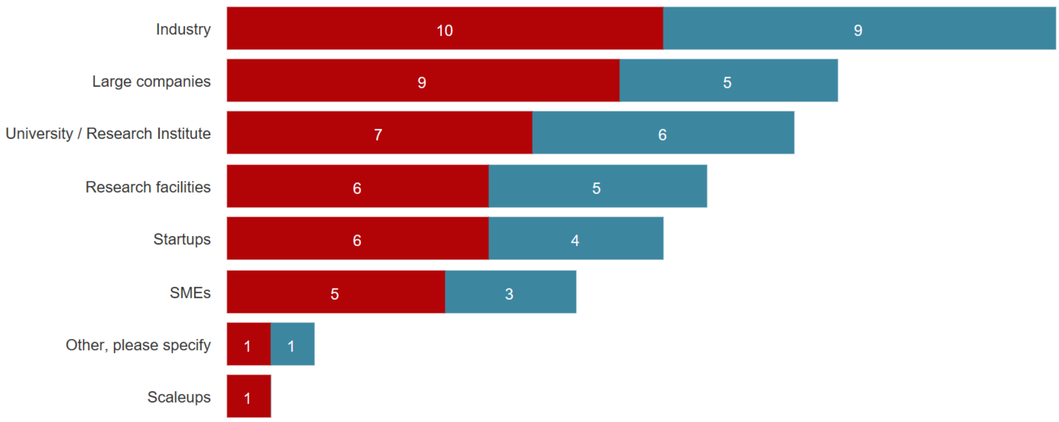
8. Age of the organisation in years

1-5	14
6-10	3
11-15	1
16-20	1
20+	2

n= 21

Customer base

9. Who are (currently) your main customers?



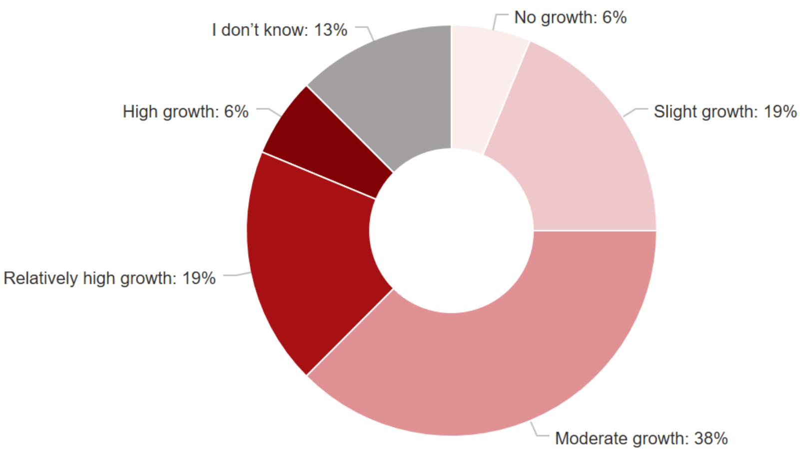
N 18

10. Do you think about other types of customers?

In your country	In another country
yes	yes
yes	not so much - only if they contact us
research organisations - CRO, Pharma companies	
Startups, Scaleups	RDI
No	Yes, Research institutes, Universities
Croatia	Yes
No, SME's dont have the money for our services and focussed on building their companies.	
Open	Open
Large companies	
-	yes
Science brokers	Scientific service providers

N 11

11. To what extent do you expect the market size to grow over the years?



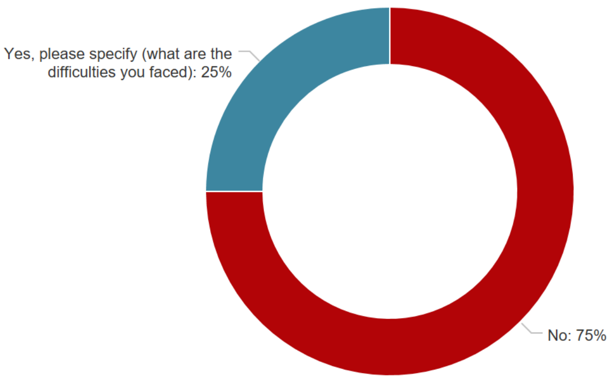
N 16

Infrastructure

12. Does your organisation require access to specific resources?

N 15

13. Does your organisation face any difficulties to access specific resources?



N 16

fast access; trial runs before customer commits (and agrees to pay:))

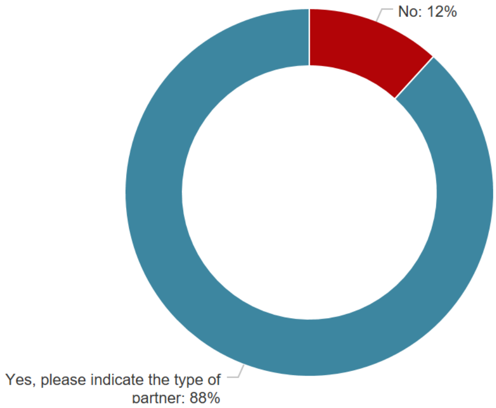
To get the right people for development is really difficult

Time to access facilities

Funding

N 4

14. Does your organisation collaborate with other partners?



N 17

many universities and RTOs

CRO, Pharma companies

research laboratories

Industry, University, RTO

Iniversity, Reserach institutes, Pharmaceutical companies

University

UNIZG-FER

6

RTO's, Universities

Universities

Industry - large, SME, Universities, clusters, Ministries

partner academies

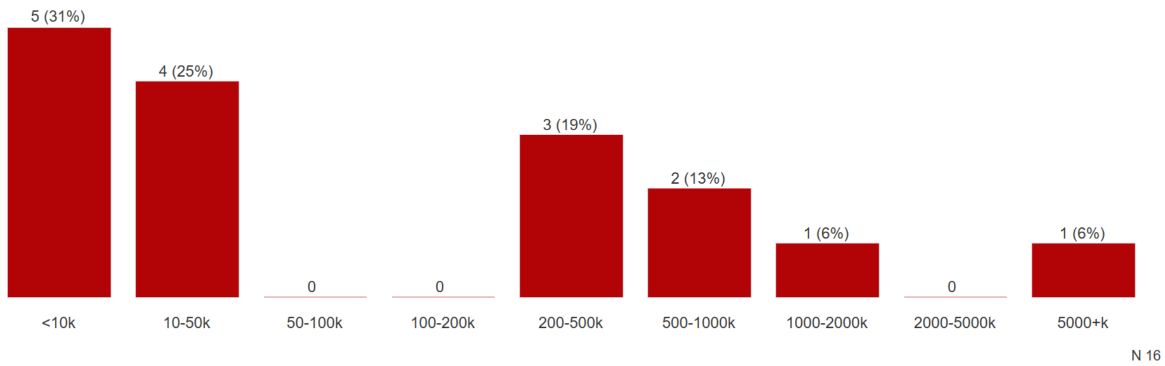
Private companies (Medical device OEM-ODM base)

with other start-up, with university and public research laboratories

N 14

Financial aspects

15. Please define your current yearly revenue



16. What are the main sources of income and what are the main costs?

Conducting trainings for customers, main expenses are travelling and hotel expenses at the clients locations.

INCOME: commercial activities: 66% - R&D: 33%. MAIN COST: buildings and personnel

We provide algorithms to other companies, and the main costs are salary.

clinical trials, doctors fee

Main sources: services for SMES's as BSO and EU projects. Main cost: salaries.

Selling our own products, and distributing general labware, the main costs are come from materials and services for production

Main costs are the HR costs and the development related expenses

Typically a split between commercial work and grant income

Consultancy; salaries

market

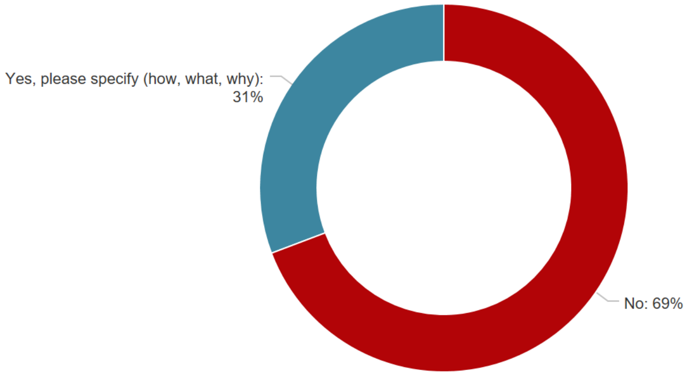
Funding from the Mkni

Source of income: Dropshiping & market consultation- Main cost: Company service provider(s)- Wellness device purchasing

Industrial clients are my main source of income. Costs are minimum as I used facilities and laboratories payed by my clients.

N 13

17. Did you have to change your business model to achieve profitability?



N 13

We had to get grants but not focussing on achieving profitability but to break even while growing

a month ago

agile organisation

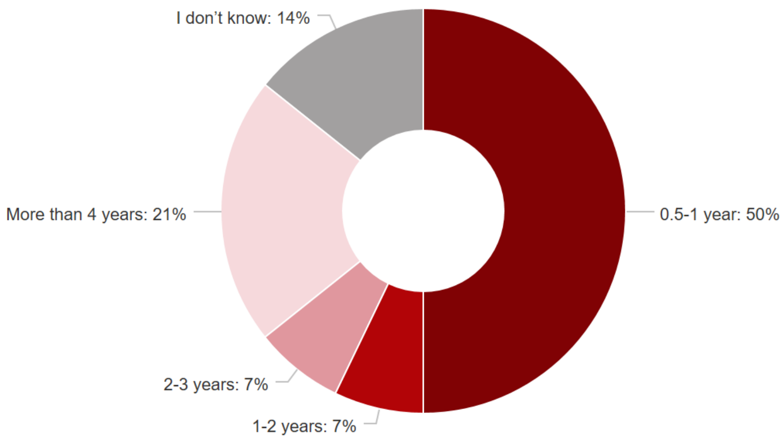
a month ago

By adding the market related consultation services

2 months ago

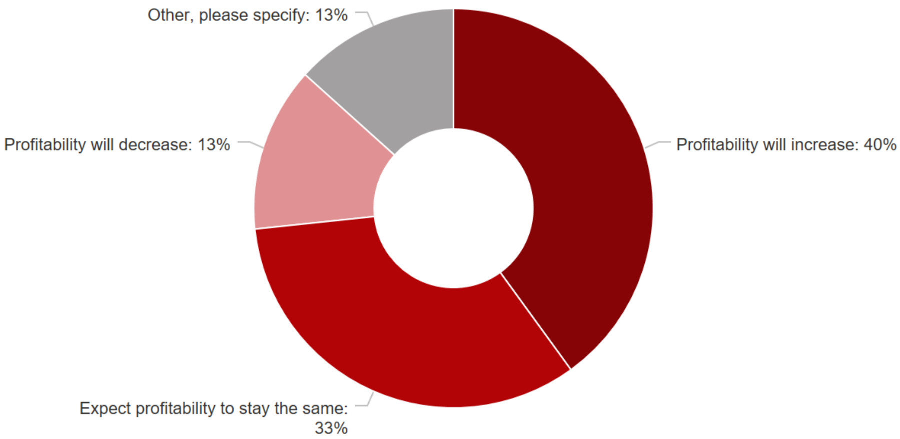
N 3

18. How long did it take to break even?



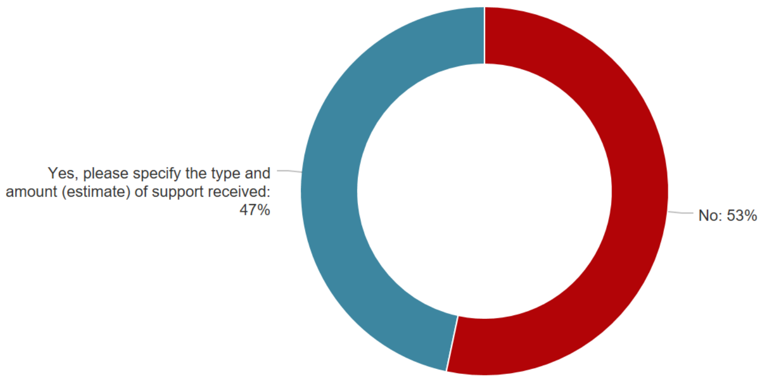
N 14

19. What are your expectations in terms of profitability?



N 15

20. Have you received any public financial support?

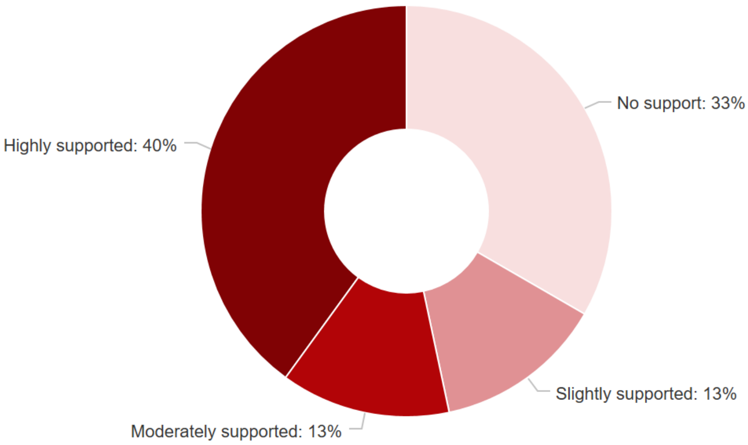


N 15

EU projects; framework R&D agreements with DK government
Business Finland, 10,000euro
Started with 100% of public support, now below 50%
Grant, and VC fund
Excluding, current financial year, over lifetime of the company we have had grants of ca. £615 (and accumulated revenue of £1.2million) i.e. ratio of 50:50
bidding on projects
annual budget based funding from the ministry of education and research

N 7

21. To what extent was your growth phase supported by public instruments?



N 15

22. What could be measures to relief financial barriers?

minor grants to support the introduction of new technologies and tools - and without a huge bureaucratic hassle of setting up, applying and reporting

explore new clients, remove travelling limit.

Prefinancing

In Hungary the taxes are high which make a hard time for companies

Probably national funds

We have been consistently growing the company by 30% per annum. Grant funding has helped us achieve this and we are almost at critical mass. SSC's like ours need second or third strand to our business. For us we have been developing our own IP - we now need financial instruments (loans or grants) to commercialise

Lack of manpower

permanent governmental support to actors in innovation ecosystem

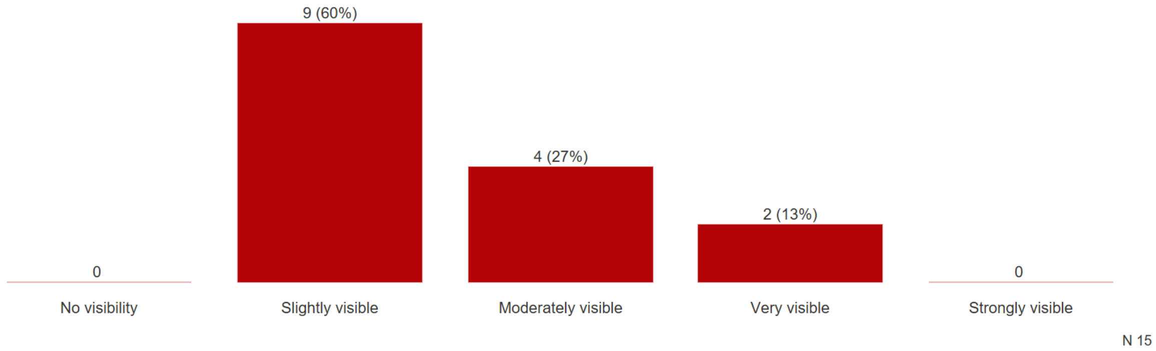
outcome delivered from evidence based policy advice

Covd-19 outbreak to end

N 10

Visibility

23. Please indicate the degree of visibility level of your company towards customers

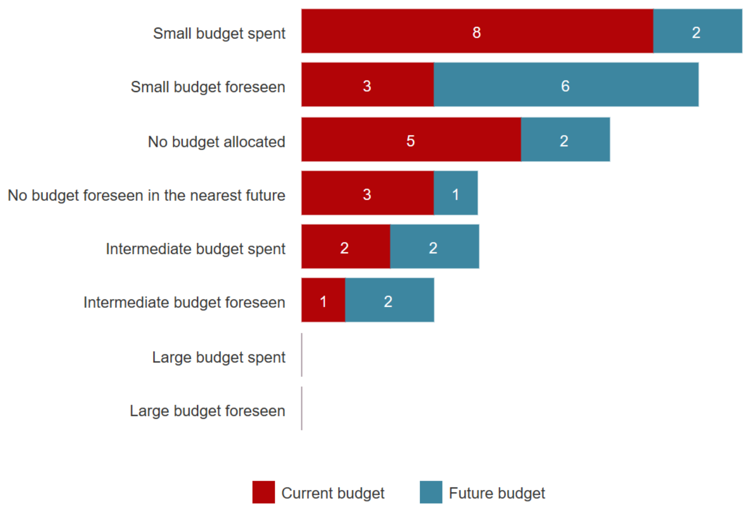


24. Please indicate what sources you usually use to increase your company's visibility

	Count	% of responses	%
Having own Website	13		87%
Through networking channels	9		60%
Through conferences and webinars	9		60%
Using social media channels (Facebook, Twitter, Instagram, LinkedIn)	6		40%
Considering implementing a visibility/marketing strategy	5		33%
Do not promote the visibility of the company	2		13%
Other, please specify	2		13%
Through content marketing	1		7%

N 15

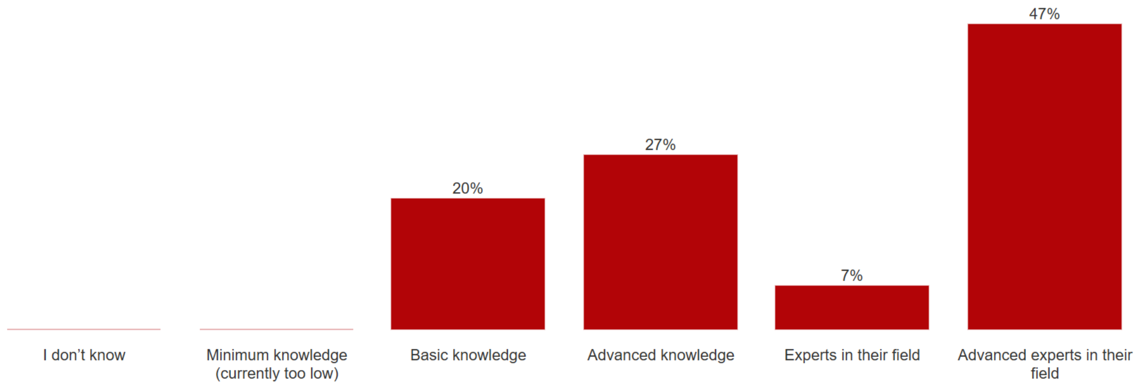
25. Please indicate if any of these options are relevant regarding budget to improve the visibility of your organisation



N 14

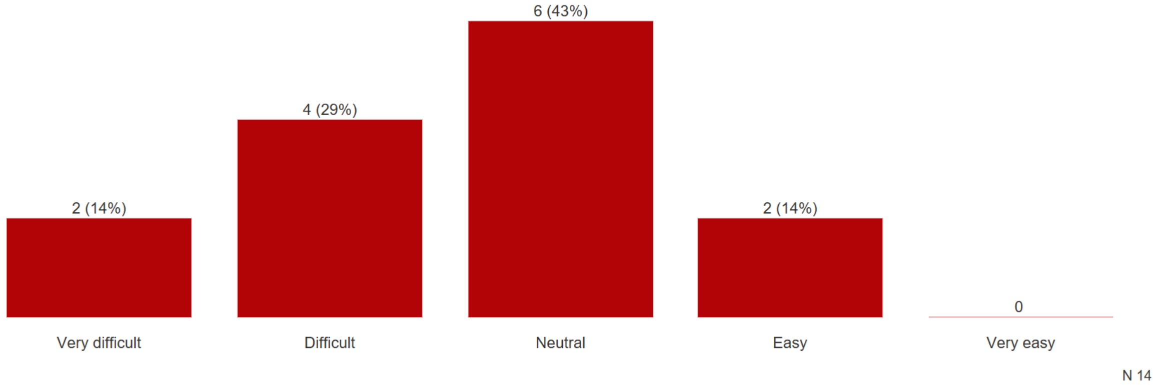
Workforce

26. How would you characterise the expertise of your staff?



N 15

27. How difficult is it for your organisation to attract new workforce?



28. If relevant, could you please describe the difficulties encountered by your organisation to attract workforce?

competition from industry

My company could not provide a high salary to attract the expert in this field.

Limited salary

We need highly educated mathematicians and programmers, and we could not afford the related expenses

None really - we recruit top talent from universities

competencies in the field and high level of self governance are often a lack

N 6

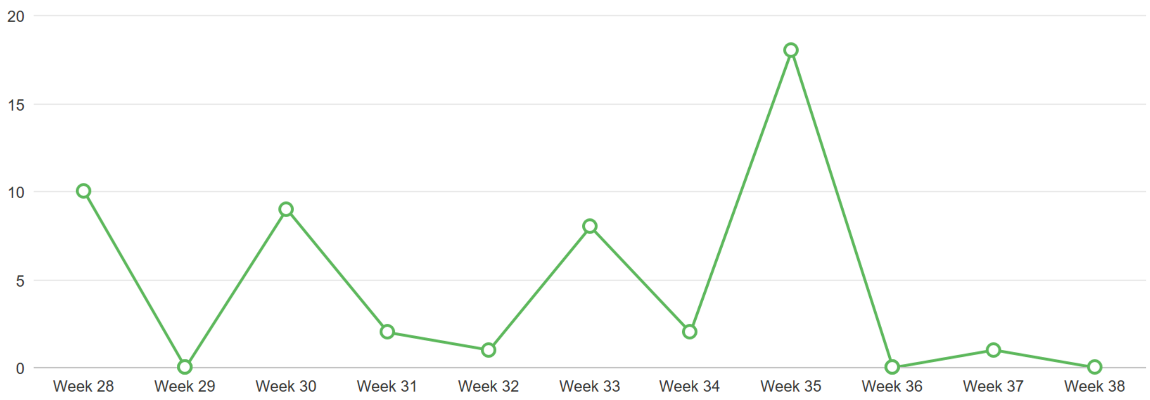
29. What types of training activities does your organisation undertake to enhance expertise of your staff

	Count	%
Technical skills development training	6	46%
Communication training	5	38%
Managerial training	4	31%
No training due to financial situation of the company	3	23%
No training needed for the staff	2	15%
Other training, please specify	2	15%
Sales training	1	8%

N 13

Background information

Timeline



N 51

Mobile vs. Desktop

	Count	% of responses	%
Desktop	44		86%
Mobile	7		14%
	51		

N 51

Browser

	Count	% of responses	%
Firefox	7		14%
Google Chrome	29		57%
Microsoft Edge	6		12%
Safari	9		18%
	51		

N 51

Operating system

	Count	% of responses	%
Android	3		6%
Apple OS X	10		20%
iOS - iPhone	4		8%
Linux	1		2%
Windows 10	32		63%
Windows 7	1		2%
	51		

N 51

Appendix B Companies identified and analysed

Source	Name	Summary of activities
CAROs	Excelsus Structural Solutions (Swiss) AG	Offers easy and affordable access to unique Synchrotron-based characterization tools developed at the Paul Scherrer Institute, to enhance the selection, development and manufacturing of high-quality (bio)pharmaceutical products.(SR-XRPD - Patent Application for new materials)
Secondary CAROs	Vironova Ab (Publ)	Swedish biotechnology company; comprehensive hardware, software, and services for the analysis of nanoparticles.
Secondary CAROs	Gimopharm	Provides support for pharmaceutical development projects.
CROs	CELLERO	Cellero delivers the most reliable biomaterials, custom research services, and clinical laboratory services to advance the discovery and development of new treatments and cures.
CAROs	CEST	Focus on material science issues relating to interfaces in the areas of corrosion, functional surfaces and applications of electrochemistry in energy technology, (bio)sensor technology and production.
CAROs	ADAPTER	Free service created by the Estonian research and development (R&D) community, to offer simple access to the best of Estonian R&D for all companies and organizations.
CAROs (+RTOs)	DTI	Solutions derived from current market requirements to the benefit of individual enterprises; Materials and surface technology develop and provide specialist services relating to new materials and processes.
CAROs	FEAC Engineering	FEAC Engineering provides solutions through engineering simulation, active in a wide range of industries, such as: aerospace, marine, high energy physics/accelerator magnets, construction, bioengineering, renewable energy, raw materials and oil & gas.
CAROs	Materize	Materize develops innovative products or meet material related needs.
Secondary CAROs	Eit Rawmaterials Gmbh	The mission of EIT RawMaterials is to enable sustainable competitiveness of the European minerals, metals and materials sector along the value chain by driving innovation, education and entrepreneurship.
Secondary CAROs	Dr. Peter Sommer Werkstofftechnik Gmbh	It is a higher education company that provides the following services: Damage analysis, Material analysis, Mechanical-technological test procedures, X-ray diffractometry, nondestructive material test, Sample preparation, Metallography, Heat treatment, Scanning electron microscopy, Research - TFWW
Secondary CAROs	Mof Technologies Limited	Metal Organic Frameworks (MOFs) are highly porous platform materials, offering game-changing possibilities in an array of industries and applications.
Secondary CAROs	Surflay Nanotec Gmbh	Surflay Nanotec focuses on functional surfaces, nanoscale coatings, polymers and microsensors.
Secondary CAROs	Polymerexpert Sa	PolymerExpert is a contract research and development firm at the forefront of polymer research and development.
Secondary CAROs	Micronit Gmbh	Micronit specializes in micro- and nanotechnologies and produces lab-on-a-chip products mainly for costumers active in the life sciences and medical field.
Secondary CAROs	Mi-Partners B.V.	Provides innovative mechatronic solutions. Its services are: Analysis on mechanical, thermal or dynamic performance; Concept generation and design of a new system; Realizing a prototype or one off system; Measurements and validation
Secondary CAROs	Monofil Srl	Provides solutions in the plastics, yarn and synthetic fibers industry.
Secondary CAROs	Rawwater Engineering Company Limited	Provides solutions for the oil & gas industry
Secondary CAROs	Delta Engineering & Chemistry Gmbh	Offers solutions in many fields, e.g.: Production and distribution of special chemistry, e.g. for electronic components; Customer-specific synthesis and/or production of fine chemistry; Contract analytics for the plating industry; Corrosion protection and damage examination according to OEM specifications; PVC immersion paints for covering plating racks; Contract development of chemical processes/products acc. to customer requirements; Development of concepts for waste water treatment; Waste water chemicals in cooperation with a strong partner
Secondary CAROs	Crb Analyse Service Gmbh	Testing laboratory
Secondary CAROs	Inphotech Sp. Z O.O.	Polish company of advanced technologies that creates modern solutions for industry based on fiber optic photonics in sectors such as railroad, gas industry, telecommunications and many more.
Secondary CAROs	Aquamarijn Micro Filtration B.V.	Develops high flux, precision microfiltration membranes, “microsieve membranes”
Secondary CAROs	Instytut Badan I Rozwoju Motoryzacji Bosmal Sp. Z O.O.	BOSMAL Automotive Research and Development Institute Ltd specialises in conducting research and development as well as manufacturing activities for domestic and foreign companies, mainly in the automotive sector.

Secondary CAROs	Vahanen Oy	Wide scope of services in architecture, building services engineering, structural engineering, refurbishment, property management, building physics, and environmental consulting.
Secondary CAROs (+RTOs)	Aimplas (non-profit research association)	Aimplas provides solutions to companies, throughout the value chain, from raw material manufacturers to transformers and end users.
CROs	Sumika Chemical Analysis Service	Sumika develops a wide range of activities from analysis to assessment for problems related to the global environment.
RTOs	A*STAR – Agency for Science, Technology and Research (public organization)	A*STAR is Singapore's lead public sector R&D agency. Through open innovation, we collaborate with our partners in both the public and private sectors to benefit the economy and society.
RTOs	CETMA – European Research Center for Technologies Design and Materials (non-profit research association)	Applied research, experimental development and technology transfer in the field of advanced materials (composites, polymers, bio-based and recycled), ICT (development of specialized software for engineering, manufacturing and services) and product development.
RTOs	Helmholtz Association	Conducts research in strategic programmes within our six research fields: Energy, Earth & Environment, Health, Aeronautics, Space and Transport, Matter, and Information. They make research in highly complex systems using our large-scale devices and infrastructure, cooperating closely with national and international partners.
RTOs	Leitat (non-profit association)	They manage technologies to create and transfer sustainable Social, Environmental, Economic and Industrial value to companies and entities, through research and technological processes.
RTOs	Łukasiewicz Research Network	Provides business solutions in the fields of automation, chemicals, biomedicine, ICT, materials, and advanced manufacturing.
RTOs	AIST – National Institute of Advanced Industrial Science and Technology	The National Institute of Advanced Industrial Science and Technology (AIST), one of the largest public research organizations in Japan, focuses on the creation and practical realization of technologies useful to Japanese industry and society, and on "bridging" the gap between innovative technological seeds and commercialization.
RTOs	AIT – Austrian Institute of Technology (non profit)	AIT provides research and technological development to realize basic innovations for the next generation of infrastructure related technologies in the fields of Energy, Mobility Systems, Low-Emission Transport, Health & Bioresources, Digital Safety & Security, Vision, Automation & Control and Technology Experience. These technological research areas are supplemented by the competence in the area of Innovation Systems & Policy.
RTOs	Eurecat - Technology Centre of Catalonia (non-profit)	Promotes competitiveness of companies and society through applied research, innovation and knowledge transfer.
RTOs	HVM Catapult	HVM Catapult's mission is to deliver economic growth by enabling UK manufacturers to achieve significant improvements in their performance and productivity. HVM Catapult does this by providing open access to world-class innovation capability and technical expertise, enabling companies to embrace different ways of working, adopt new technologies and achieve a step change in performance.
RTOs	JOANNEUM RESEARCH (non-profit)	JOANNEUM RESEARCH develops solutions and technologies for a broad range of industries and public agencies and is engaged in top applied research at an international level. Optimally embedded in the national and international innovation network our staff develops innovations in the three thematic areas of information and production technologies, human technology and medicine, society and sustainability.
RTOs	NIC - National Instityte of Chemistry	Basic and applied research are oriented towards fields which are of long-term importance to both Slovenia and the world: biotechnology, environmental protection, structural and theoretical chemistry, analytical chemistry, materials research, and chemical engineering, through which the institute is in line with the needs of the domestic chemical, pharmaceutical, tire, and food industries.
RTOs	Nofima AS	Nofima is a leading institute for applied research within the fields of fisheries, aquaculture and food research.
RTOs	RISE Research Institutes of Sweden AB (non-profit)	RISE is Sweden's research institute and innovation partner. Through our international collaboration programmes with industry, academia and the public sector, we ensure the competitiveness of the Swedish business community on an international level and contribute to a sustainable society.
RTOs	Tecnalia (non-profit)	TECNALIA is a leading Research and Technological Development Centre in Europe, whose mission is to transform technology into GDP to improve people's quality of life, by creating business opportunities for companies, being member of BRTA (Basque Research and Technology Alliance).
RTOs	TNO (non-profit)	TNO connects people and knowledge to create innovations that boost the competitive strength of industry and the well-being of society in a sustainable way.
RTOs	UAR – Research Center for Non Destructive Testing GmbH (RECENDT)	The services incorporates the whole R&D process chain and stretches from application-oriented fundamental research to the development of state-of-the-art technology for industrial applications.

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