EESTI ARENGUFOND

Smart Specialisation – Activities

Analysis of Bottlenecks and New Opportunities

Estonian Development Fund

Interim Report, 19 June 2013

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Foreword

Two analyses have previously been carried out in Estonia on the topic of smart specialisation: the quantitative analysis prepared by the workgroup led by Urmas Varblane and the qualitative analysis done by the Estonian Development Fund[1]. Eight economic sectors where the presently created added value is the highest were selected on the basis of the quantitative analysis. As a follow-up to this, the Estonian Development Fund carried out a qualitative analysis in which it considered future trends and the cooperation potential for enterprise and science in each of the sectors. The selection had to be narrowed down, as eight areas of growth would have been too much to manage. Three areas of growth were selected as a result of this analysis:

1. Information and communications technology (ICT) horizontally via other sectors, including[2]:
   a) use of ICT in industry (incl. automation and robotics);
   b) cyber security; and
   c) software development.

2. Health technologies and services:
   a) biotechnology (strong scientific base); and
   b) e-health (use of IT for the development of medical services and products).

3. Enhancement of resources:
   a) industry involved in enhancement of materials;
   b) knowledge-based construction;
   c) food that supports health; and
   d) chemical industry (more efficient use of oil shale).

This document is an analysis of the bottlenecks and the new opportunities in various areas with a high growth potential. It was prepared on the basis of the two earlier analyses for the purpose of finding the smart specialisation activities – obstacles whose elimination would have the greatest impact on advancing innovation. The ministries operating under the guidance of the Ministry of Economic Affairs and Communications (MEAC) and the Ministry of Education and Research (MER) will use this analysis of bottlenecks as the basis for the development of specific measures that will be implemented starting from 2014.

Another important factor for smart specialisation is its management structure that is to be created for the period 2014-2020. Cooperation between ministries is important for smart specialisation measures – many growth areas concern several ministries. It is therefore necessary to create a steering committee reaching across ministries in the respective growth areas. So far the Estonian Development Fund has led the smart specialisation process in Estonia and is prepared to take the leading role in further smart specialisation activities.

European source documents have emphasised that when it comes to smart specialisation the state must select specific activities, instead of broad sectors. The reason for this is that an increasing number of business opportunities cross the borders between traditional sectors in the common activities of synergic parties. Focusing on sectors would be a choice that is too broad: it is necessary to find specific activities that support innovation. Selecting specific areas of growth was therefore only part of the process in the case of smart specialisation. This current analysis is focusing on specific activities.

In order to identify bottlenecks in the key areas, focus groups were formed where the options of scientists and entrepreneurs were used as input for the given analysis. In addition, the Estonian Development Fund used its own expertise to expand on and to clarify the bottlenecks even further.

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[1] http://www.arengufond.ee/upload/Editor/Publikatsioonid/Nutikas%20spetsialiseerumine%2020_02_2013.pdf
[2] Unlike other areas of growth, the sub-sectors highlighted for ICT are examples and the area is not restricted to them. The ICT sector is highly homogenous, which makes a narrower definition of the sector's opportunities unnecessary.

1 The structure of the bottleneck analysis

The bottlenecks are presented in two parts in the following chapters: Chapter 2 focusses on bottlenecks that concern the broader economic environment and whose resolution would benefit all areas of growth, and Chapters 3-5 take a closer look at the bottlenecks in each area of growth. The task of the Estonian Development Fund was to identify the bottlenecks that will be used as input for the preparation of operational programmes in ministries. This means that the measures offered in regard to bottlenecks are only indicative and their purpose is to explain the specific nature of the bottlenecks.

The title of this document is 'Smart Specialisation – Activities. Bottlenecks and New Opportunities'. The reason why new opportunities were added to the analysis of bottlenecks is that in several areas of growth it is important to see new opportunities, not only challenges, i.e. the solutions that do not yet exist to a significant extent but that do have potential for R&D investments in the future.

The Estonian Development Fund carried out an econometric analysis to assess the scale of the role the ICT sector could play in the further economic growth of Estonia. According to estimates the economic growth generated by the ICT sector in Estonia could range from 0.9-1.3% during this decade. If we assume that the entire economy will grow at a rate of 4-5%, it can be said that *ca*. one quarter of Estonia's economic growth this decade may come from the ICT sector. Employment in the ICT sector currently comprises just 4% of employment in Estonia, but its economic impact is considerably broader. The sector's productivity is also higher than in many other sectors. This is why the manner in which the ICT sector develops is extremely important for the Estonian economy and why this analysis places significant emphasis on the measures in the ICT sector. The Estonian Development Fund sees the ICT sector as the growth area with the biggest potential and up to 50% of the funding given to growth areas should be used to advance this sector. The implementation of the 'Information Society Development Plan' to be created by the MEAC plays an important role in the elimination of bottlenecks in the ICT sector.

It can be said that *ca*. one quarter of Estonia's economic growth this decade may come from the ICT sector.

The second important conclusion drawn on the basis of the econometric analysis is that the impact of the ICT sector on the economy via other sectors is even greater than the direct impact– it is estimated to be up to three times higher. This is why the bottlenecks whose elimination would help improve the implementation of ICT in other sectors are separately listed in Chapter 3.

The Estonian Development Fund has analysed sectors and activities from two aspects:

1) What are the sectors and activities in which Estonian companies could be globally competitive with the help of R&D?
2) What are the sectors and activities in which Estonia could use its existing enterprise and the resources located in Estonia more efficiently with the help of R&D?

Whilst many ICT solutions fall into the first category, the oil shale industry and the food that supports health belong to the second, i.e. we have to look for opportunities that allow us to use our existing resources more efficiently. However, different sectors require different approaches, which is why the specific features of each sector were considered separately in the analysis of bottlenecks.

Smart specialisation is a process that requires Estonia to continue with already existing activities while also starting with further steps which are described in Chapter 6.

Extra 1.
The different use of technology in the growth areas

The growth areas of smart specialisation are of different types and the use of technology varies between them. For example, looking at the ICT sector, we see that it is a horizontal sector interacting with other sectors thereby increasing their efficiency (see Figure 1). For Estonia, the potential of ICT is bigger in the implementation of already developed technologies instead of focusing on the creation of new technologies.

Enhancement of resources, however, mostly covers vertical sectors whereby we have to analyse which technologies can increase R&D activities in each sector. Figure 2 depicts the structure of how to analyse various horizontal technologies in the case of food and timber in order to identify those whose use has the greatest potential in Estonia.

Knowledge-based construction (e.g. construction of wooden houses) described in Chapter 5.2 can be given as the third example of the use of technology. In regard to this area of growth, it is important to emphasise from the aspect of technology that it is necessary to combine various technologies: energy technologies, materials technologies and information technology. These must be combined to increase competitiveness and, as a result, exports (see Figure 3).

Figure 1. ICT as a horizontal technology, helping other sectors

Figure 2. Different technologies create opportunities for resource enhancement.

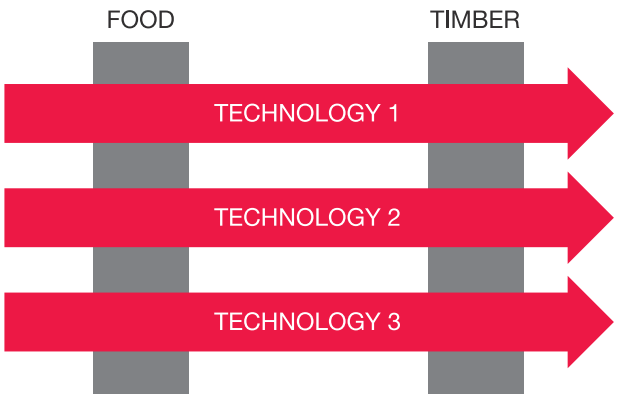
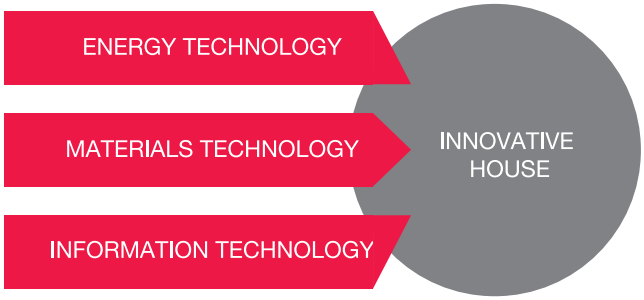


Figure 3. Combining different technologies is important in knowledge-based construction.



2 Common bottlenecks in the areas of growth

The growth areas of smart specialisation have different specific economic features, but there are some bottlenecks whose resolution would support all growth areas. These are highlighted in this chapter.

2.1. THE ECONOMIC POTENTIAL IN THE GROWTH AREAS IS UNDEREXPLOITED DUE TO THE SMALL VOLUME OF R&D INVESTMENTS

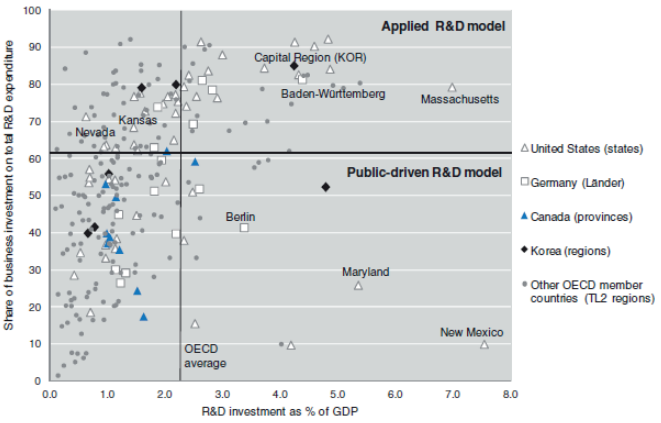
Solution: improving cooperation between enterprise and research is necessary for all growth areas and moving in this direction is the goal of this analysis. However, there are some broader measures that would support this: firstly, entrepreneurs have realised the need for an applied science partner with analytical capacity that would focus on them. The activities of competence centres (CC), which have created the basis for improving cooperation between entrepreneurs and researchers, can be highlighted as a positive example. It is necessary to continue supporting the activities of CCs, but it is also necessary to assess the efficiency of their current activities and to increase the percentage of financing by enterprises in the development work of CCs from 2014-2020. It is necessary to carry out an in-depth analysis of CCs to define further financing.

Secondly, it is important to support the applied research in research institutions, which has to be done in cooperation with entrepreneurs, e.g. via targeted national programmes.

Estonian clusters require additional analysis: as we assess the efficiency of current activities, we must identify the clusters with which to continue. In the case of CCs it is important that sectors are selected similar to the chosen growth areas, but this is not required in the case of clusters. The reason for this is that the task of CCs is to increase applications in the area of innovation, but in the case of clusters the emphasis is on the ability to bring entrepreneurs together and on the quality of marketing activities. This is why these should also be the main priorities in assessment instead of focusing on an overlap with growth areas.

Measure: development of CC(s) open to entrepreneurs, continuing to finance CCs, supporting applied research in research institutions and universities

Figure 4. Share of private sector in R&D investments and share of R&D in GDP (source: OECD)



The y-axis in Figure 4 shows the share of the private sector in R&D investments of the relevant country, while the x-axis shows the state's R&D expenditure as a percentage of GDP. The figure indicates that statistics are moving towards north east, i.e. as a rule, the volume of R&D in a country only grows if the private sector increases its R&D investments. This means that Estonia cannot rely solely on the state when it comes to R&D investments, as it would not be sustainable. This is why it is important to develop the private sector's knowledge and capacity in the area of R&D investments and to improve cooperation with universities in the area of innovation. It must also be emphasised that when it comes to R&D investments, we cannot just assume that the R&D investments of existing companies will grow; instead, we have to focus on the creation of new companies that can do this.

2.2. FINANCING TO SUPPORT RESEARCH-INTENSIVE START-UPS IS INSUFFICIENT

Solution: in the case of financing from European structural funds for the period 2014-2020, the European Commission recommends increasing the use of financial instruments instead of direct grants. Different financial instruments are suitable for companies in different sectors and different growth areas: loans or loan guarantees can be appropriate for more mature companies whilst equity investments would be better for start-ups. Financing start-ups (seed financing) can be considered a problem in the ICT and biotechnology sectors in particular, because involving foreign investors is easier for companies that already have clients on global markets, but reaching clients is often resource-intensive. This is why the priority of these two sectors should be emphasised in the fund of funds structure.

> Financing start-ups (seed financing) can be considered a problem in the ICT and biotechnology sectors in particular

A fund of funds-type structure would be a suitable measure to support this: the state would invest in partnership with funds operating on the regional level (Scandinavian and Eastern European) via a management company that handles the day-to-day management and the selection of investments. Initial estimates indicate that it would be necessary to invest 15 million euro per year in start-ups in Estonia, part of which would be covered by the private sector. Estonia is very small, which makes the creation of a separate fund for each growth area difficult, so it would be necessary to combine funds for several growth areas. It is also important to cooperate with Scandinavia and the other Baltic States. The fund's investments should not be restricted to just one country.

Measure: fund of funds for supporting start-up investments

2.3. INCREASE THE EMPHASIS ON INCUBATORS AND SEED ACCELERATORS

There are several examples of successful seed accelerators and incubators in Estonia (such as Startup Wiseguys, Tehnopol Startup Incubator, GameFounders and Garage48). Incubators play an important role in all research-intensive enterprise and form part of the complex measure for its development, which is given in Annex 2. Incubators and seed accelerators can be the places where the entrepreneurs and researchers involved in the creation of a research-intensive company meet and carry out the first tests of practical applications. Their role is also important in respect of the entire development chain of companies – as the next step companies that grow out of incubators can involve the capital of investors that offer seed financing. If there are too few incubators and seed accelerators or if they are weak, opportunities to make following early phase investments are limited.

Incubators and seed accelerators have been supported in Estonia, but it is necessary to create an even more stable system and to establish incubators in the particular growth areas.

Measure: supporting seed accelerators and incubators

2.4. MEASURES THAT SUPPORT R&D ACTIVITIES ARE FRAGMENTED AND COOPERATION BETWEEN CLUSTERS AND CC-S IS INADEQUATE

Solution: one of the problems emphasised in the smart specialisation documents of the European Commission is that innovation activities are typically highly fragmented and it is necessary to concentrate competencies. A similar problem was also highlighted in the analyses that focus on R&D activities in Estonia. Measures supporting R&D have become fragmented and should be consolidated. The IT Academy (ITA) was established and actively launched in the area of ICT, which partly helps consolidate this sector. There is no such consolidating centre in the areas of medicine, resources and materials research. Collecting sectoral expert knowledge is necessary in all growth areas.

This could be achieved through the establishment of a Growth Area Development and Innovation Centre (GADIC), whose tasks could be as follows:

- Improving cooperation between clusters and CCs (incl. with research institutions and universities). The existing legal form could be preserved for both and concentration should be aimed at improving cooperation.
- Development of smart specialisation strategies; monitoring and analysis; participation in management activities; development and monitoring of indicators.

In the creation of the GADIC structure Estonia could use models developed abroad, such as the Finnish OSKE (www.oske.net) or VTT (www.vtt.fi). The models should not be copied exactly as they are, but we could take advantage of

the experience of the Nordic countries and use it as a basis for building a structure suitable for Estonia by involving parties operating in this direction (such as the National Institute of Chemical Physics and Biophysics and the Estonian Research Council). Establishing a new agency would not be practical, as the Estonian Development Centre is prepared to create GADIC as a sub-agency and take responsibility for launching it.

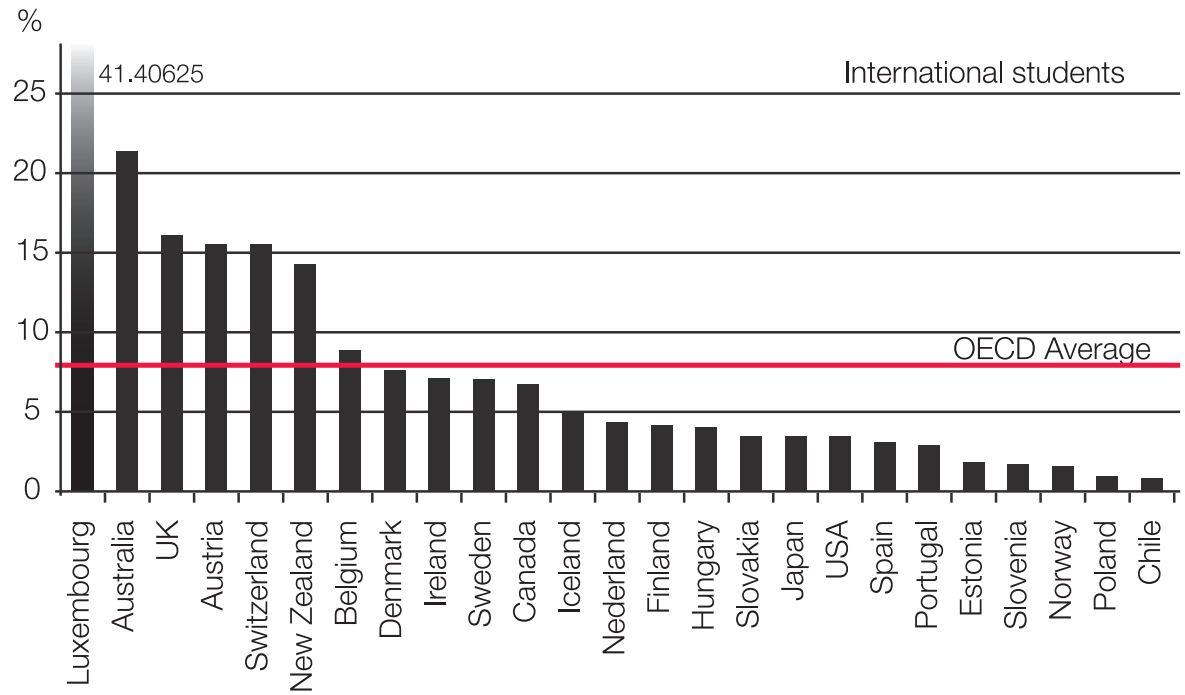
Measure: the creation and funding of GADIC

2.5. BRINGING FOREIGN WORKERS TO ESTONIA IS DIFFICULT

Solution: when we look at the IT sector, it is clear that Estonia's workforce alone cannot meet the sector's personnel demands. Also, many enterprises have highlighted the difficulty of bringing foreign workers to Estonia, especially from countries outside of the European Union. This is a serious issue and could mean that instead of Estonia, a strong and growing company or development entity is established in a country where migration laws are more favourable.

An additional problem is with foreign students who have come to study here from third countries but have to leave Estonia after completing their studies. Ideally, many of them would be employed in Estonia, especially in sectors related to the selected growth areas. Another problem is that it is difficult for foreign students to find jobs in Estonian companies. A necessary solution would be to create a system for foreign students that would make it easier for them to find work. The share of foreign students compared to the overall size of the student body can be seen in Figure 5. We can see that the indicator in Estonia is considerably below the OECD average.

Figure 5. Share of foreign students per country (2009, source: OECD)



Immigration is certainly a sensitive social topic, but when we look at Sweden we see that the emphasis there has been on bringing in cheap labour from foreign countries to increase the supply of labour for simple jobs. However, Estonia needs the opposite: to bring in highly educated and well-paid specialists for growth areas (so-called 'smart immigration'). In their case, the risk that they will not adjust to the local circumstances is considerable lower. The international contacts and experiences that these specialists bring are also significant, as exports are very important for all three selected growth areas.

Estonia needs the opposite: to bring in highly educated and well-paid specialists for growth areas (so-called 'smart immigration')

There are numerous signals that people in many western countries think along the same lines and that competition for educated specialists is increasing between states all over the world, which means that Estonia's strategic activities in this direction must be given even more importance. In addition to facilitating the immigration of specialists, it is also necessary to provide them with a quality social environment (schools, kindergartens etc.) after their arrival.

A positive point that can be highlighted is the initiative of the Ministry of the Interior, the Ministry of Economic Affairs and Communications and the Ministry of Education and Research, disclosed in April 2013, which formed the basis for planning a legislative amendment to make it easier for foreign specialists to work in Estonia[3]. The Riigikogu approved this amendment on 13 June 2013.

Measure: smart immigration – 'green light' residence permits for specialists who earn at least twice the average Estonian salary or have a doctorate degree

2.6. INADEQUATE INTERNATIONAL COOPERATION IN R&D

Solution: international cooperation is extremely important for smart specialisation as more and more companies in the world are transnational (in terms of both their teams and clients). International cooperation is necessary with regard to the existing European support measures (by identifying the possible additional measures that suit Estonia) as well as for cooperation within the scope of smart specialisation. Priorities in terms of international cooperation must be determined, as there are programmes of different quality. It is also necessary to create systematic and permanent analysis of the European support programmes in which Estonian research institutions and companies could participate. This would be a suitable task for GADIC after its creation. For example, the accelerators operating in Estonia are already engaged in international cooperation and GADIC can use the competencies gained from this as the basis for broader promotion of international cooperation.

Priorities in terms of international cooperation must be determined

As smart specialisation is analysed on the regional level in the European Union, the national smart specialisation strategies of the Nordic countries are likely to be completed only by the end of 2013 on the basis of regional strategies. Discussions of cooperation opportunities with the Baltic States can start earlier, but with the Nordic countries it will not be possible before autumn 2013. As Norway is not a member of the European Union, analysing smart specialisation there is an option; the Nordland region is the only one that is currently involved in the process.

Measure: make GADIC responsible for activities related to international cooperation projects.

2.7. THE TAX ENVIRONMENT SHOULD BE MORE SUPPORTIVE OF INNOVATION

Solution: the social tax cap is very important in innovative areas where salaries are considerably higher than the average. The social tax cap would help make Estonia a more attractive destination for foreign specialists, because currently the labour taxes payable in Estonia on the recruitment of highly paid staff are higher than the European average. This is why the establishment of a social tax cap could be considered for all smart specialisation growth areas. This idea was repeatedly highlighted by many of the entrepreneurs interviewed by the Estonian Development Fund.

Another issue to be taken into consideration is the taxation of options in the selected growth areas, as there are many start-ups in these areas where employees are motivated with equity options. The bottleneck in the present system is that there must be at least three years between the issue and settlement date of options. In some cases this can become a highly restrictive bottleneck. It is understandable that this restriction helps prevent potential abuse of options, but there could be some exceptions. For example, the three-year requirement would not apply if the options were issued by a listed company (this would promote bringing the development units of large foreign companies to Estonia and in many cases such activity is also regulated and supervised in the case of listed companies), or if the company is acquired by a new owner after the issuing of holding options.

Another issue to be taken into consideration is the taxation of options in the selected growth areas

Measure: establishment of a social tax cap, changing the taxation of holding options

2.8. INSUFFICIENT VOLUME AND LOW QUALITY OF NATURAL SCIENCES AND ENGINEERING EDUCATION IN ESTONIAN BASIC AND SECONDARY SCHOOLS

Solution: in order to have more science and engineering taught in universities, we have to start laying the foundations in earlier stages. Increasing the volume and quality of natural sciences and engineering education in basic and secondary

[3] http://arvamus.postimees.ee/1198640/ministrid-eesti-talentidele-avatuks/

schools is therefore important. In addition to basic education it is also important to support the activities and creation of hobby clubs. ProgeTiiger and the translation of CodeAcademy into Estonian are highly positive examples of this. It is also important to continue popularising natural sciences and to emphasise the importance of innovation in cooperation with entrepreneurs.

Massive open online courses (MOOCs) are rapidly developing around the world and this development is likely to continue as more and more people study online. As the younger generation in Estonia has the readiness to use these solutions, it would be a highly effective opportunity to acquire new knowledge. Creation and utilisation of MOOCs should be encouraged and supported. One idea is to translate solutions like www.khanacademy.org into Estonian in addition to local content creation.

Natural sciences and engineering are not the preferred choice at the level of tertiary education in many OECD countries. "On average, 37% of students in OECD countries who completed Tertiary-type A[4] programmes chose to study social sciences, economics and law; 25% chose humanities, arts and teacher training; and 13% chose medicine and healthcare-related specialities. Less than 30% of graduates in Tertiary-type A education in Denmark, Finland, Korea, Norway, Sweden and Turkey acquired a degree in social sciences, business or law." (OECD[5] , 2008: 206). Estonia stands out negatively in the comparison of OECD countries, because the number of students graduating with degrees in social sciences is high and the number of those completing natural sciences and engineering studies is relatively low.

Measure: support the teaching of natural sciences and engineering in secondary school, support natural sciences and engineering hobby groups and innovation groups for students, support online learning environments

2.9. THE POTENTIAL OF KNOWLEDGE-BASED START-UPS HAS NOT BEEN ADEQUATELY USED IN UNIVERSITIES

Solution: there are too few examples in Estonia where research projects have moved on from universities as spinoffs with the cooperation of the private sector. There is vast unused potential in this in all growth areas and such activities must be supported by both the legal structure and applied research by scientists. This gives universities the chance to earn financial revenue and maintain holdings in projects by contributing intellectual property. Supporting spinoffs is extremely important in smart specialisation and a complex approach to this is described in Annex 1. The only way a spinoff can be successful is if it has strong business acumen and access to capital in addition to the research base.

Another bottleneck mentioned in many interviews conducted by the Estonian Development Fund is the fact that researchers find it difficult to spend time working with private sector companies, because it makes it harder for them to return to research afterwards, since bibliometric indicators are the main criteria in the assessment of scientists. Changing the assessment system completely would be difficult, but the problem could be mitigated with the introduction of a 'business break': an idea that allows the researcher who starts working in a seed company to return to the university and continue their previous work within two years.

Measure: support spinoffs of university research projects, support independent launch of spinoffs with financial instruments, restructuring and broader support for the Spinno project.

The only way a spinoff can be successful is if it has strong business acumen and access to capital in addition to the research base.

2.10. SPECIALISTS WITH STRONG (INTERNATIONAL) EXPERIENCE DO NOT SWAP PAID EMPLOYMENT FOR THE ROLE OF AN ENTREPRENEUR

Solution: the 35+ measure supports the establishment of companies by well-educated and experienced specialists. Establishing their own companies is difficult for people who have reached a certain age, as many have families and financial obligations. However, statistics indicate that companies created by people of this age (typically above 35) and experience are considerably more likely to succeed than companies created by people aged under 30. US academic Vivek Wadhwa analysed seed companies in the United States and found that the average age of the founders of successful seed companies was 40[6].

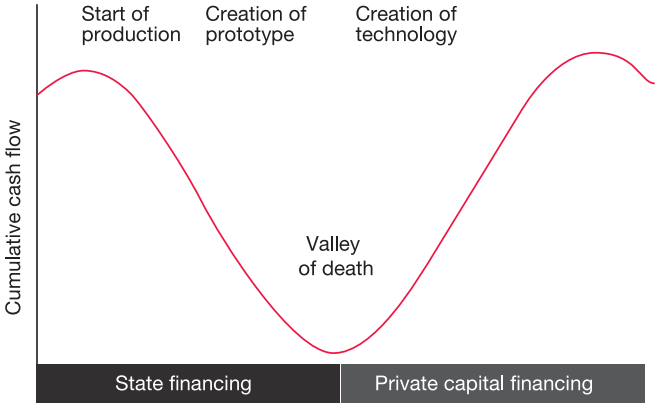
[4] Tertiary-type A (ISCED 5A) programmes in universities are largely theory-based and designed to provide sufficient qualifications for entry to advanced research programmes and professions with high skill requirements . http://stats.oecd.org/glossary/detail.asp?ID=5440.
[5] Santiago, P. Tremblay, K. Basri, E. Arnal, E. Tertiary Education for the Knowledge Society. Volume 2. 2008.
[6] http://papers.ssrn.com/sol3/papers.cfm?abstract_id=143126

Under the 35+ measure they are paid an "entrepreneur's salary" for 12 months, which partly maintains their income but also allows them to establish their own companies. The emphasis could be on supporting Estonians working abroad to motivate them to return to Estonia.

Cooperation with seed capital and incubators is important, as it guarantees such entrepreneurs the capital they need to start a business whilst the incubators provide them with the necessary environment and consultations. Incubators may also be the ones that select suitable projects. The 35+ measure would provide significant support in the creation of a seed investment fund of funds, as it would make it possible to create more companies that are suitable for investments.

Measure: creation of the 35+ measure, mainly via tying it to the incubator programme and start-up investments

Figure 6. 'Valley of death' as a bottleneck in the development of research-intensive business



Annex 1. Supporting the development of research-intensive start-ups

The global bottleneck in research-intensive start-ups is the gap between the stage where scientific analysis is carried out and the stage where the company starts generating turnover. This stage is also called the valley of death, because the existence of this gap means that many research-intensive projects never achieve commercial success. Financing is easiest to find before the valley of death when the state often finances scientific analysis. Financing also exists after the valley of death – finding venture capital is considerably easier once evidence of commercialisation has been (or is about to be) found.

How to minimise the role of the valley of death is therefore a very important question. Minimising or eliminating this bottleneck would considerably increase the share of research-intensive companies. This is the factor that is considered in the analysis of the general smart specialisation bottlenecks listed in this chapter.

The following grouped activities should minimise this bottleneck:

1. **Supporting the spinoffs of universities** – this guarantees the scientific basis required for research-intensive enterprise.

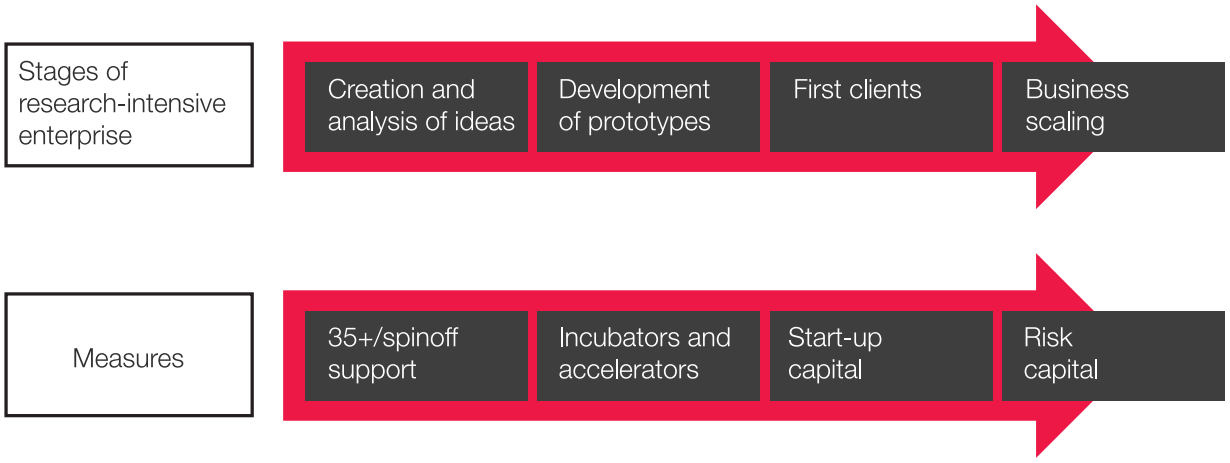
2. **35+** – this measure makes it possible to add a research base and business knowledge to start-ups. Adding business knowledge is of critical importance for the spinoffs of universities, as commercialisation is otherwise very difficult.

3. **Incubators** – incubators provide the support structure that helps increase the probability of research-intensive start-ups succeeding and completing the incubation phase with better results.

4. **Start-up fund of funds** – the previous three steps guarantee that research-intensive enterprises of sufficient quality are created. Adding a fund of funds to the mix increases the financing available and therefore reduces the risk of a valley of death. This means that all four points are necessary – skipping the first two creates a considerable risk for the fund of funds regarding the quality of the companies.

Figure 7 shows the different stages in the development of a research-intensive company and the measures that the state can use to support research-intensive companies in their different stages of development. All those measures are an important part of the development chain and all must be executed well to improve the research intensive early phase entrepreneurship.

Figure 7. Stages of research-intensive enterprise and measures supporting each stage



3 Bottlenecks and new opportunities of ICT

3.1. ICT SECTOR

The ICT sector differs from other growth areas as it provides horizontal support to other sectors. This is why the sub-sectors highlighted by the selection of growth areas (in the case of ICT the use of ICT in industry, cyber security and software development) are only examples rather than fixed selections, such as the sub-sectors of health technologies and resource enhancement. ICT is a more homogenous sector and developing the general environment for the broader use of ICT in other sectors should be the main focus. This is why the approach to finding bottlenecks in ICT has been somewhat different from other sectors.

3.1.1. Shortage of ICT specialists

Solution: The Estonian Association of Information Technology and Telecommunications forecasts that in 2020 the ICT sector will be able to offer twice as many jobs compared to 2012, i.e. the number of people working in the ICT sector may increase from 17,000 to 34,000. However, when we look at the present structure of education, it is clear that the university graduates cannot meet this increase in demand. Smart immigration could be used to remedy shortage of labour (wherein it should be easier to employ strong specialists in Estonia), but it is also important to increase the volume of tertiary ICT education so that the majority of the increase in demand can be covered by Estonian specialists. Students graduating from Estonian universities will be able to satisfy just one-third of the demand in the ICT sector if the present system is not changed.

Measures:

- The scope of state-commissioned IT education should be increased (especially at the University of Tartu and the IT College) – the business sector can absorb this increase.
- The international competitiveness of Estonian IT education must be increased: bringing foreign researchers to Estonia, increasing the amount spent per student 1.5 times (incl. raising the ratio of students to professors to 15:1 and increasing the average salaries of professors).
- Development and promotion of self-education programmes.
- Speciality grants for ICT students (and also for students of other growth areas). Students acquiring their doctorates in ICT should also be given more support to guarantee that universities have future lecturers available and that the quality of research improves.

3.1.2. The growth of R&D investments is slowed down by the bigger share of services over products in the ICT sector

> Estonian IT sector should move from the provision of services more towards the development of products

Solution: the ICT sector in Estonia is largely focussed on the provision of services. Services have the advantage of lower entry barriers, but they offer lower scalability than products do. This is why the Estonian IT sector should move from the provision of services more towards the development of products. Product development often requires large investments and, considering the capital structure of Estonian companies, they currently do not have the enough capacity to make such investments. It is therefore important to support the conversion of the already existing competencies into products. Creating product spinoffs from operating companies as spinoffs (e.g. ZeroTurnaround) is a similar approach.

Measure: supporting R&D investments

3.1.3. Low export capacity of Estonian ICT companies

Solution: The main obstacle that prevents Estonian ICT companies from being successful in exporting is their inability to find clients on foreign markets. A contact network is extremely important in this case and very few Estonian employees have this on the global market. This is why attempts to grow with local efforts often hit a ceiling and companies need help to take products to international clients. The main bottlenecks are management (having a network there is also very important, both in finding investors and clients as well as in hiring foreign specialists) and sales. For example, one of the critical factors in the success story of Modesat (a company sold to Xylinx in 2012 which is a listed US company) was the hiring of a manager with global competency (Bernard Xavier). It is also important for Estonian companies to find new R&D specialists, as target markets are often global and companies need to involve specialists with more experience.

Measure: support bringing foreign employees to Estonia (management, R&D specialists and sales)

3.2. APPLICATION OF ICT IN OTHER SECTORS

3.2.1. Large unused potential for using ICT solutions in other sectors

Solution: looking at the structure of Estonian businesses, we see that almost all sectors have the potential to increase their efficiency with the help of ICT. Doing this requires an analysis of possible applications and improving cooperation between sectors, and the ICT sector itself must also cooperate more actively with other sectors to map opportunities.

Measure: support the use of ICT in other sectors to increase efficiency

3.2.2. The R&D investment opportunities of ICT are restricted by inadequate ICT competency in other faculties

Solution: interdisciplinarity and application of solutions in cooperation between sectors is increasingly important in ICT R&D. A suitable support mechanism in the case of R&D would be to support ICT-related research in the other faculties at universities. Additional ICT training for employees from other sectors can also be considered necessary.

Measure: supporting ICT-related research in other faculties and other (non-IT) areas

3.2.3. Insufficient use of robotics in Estonian industries

Solution: the global industry keeps moving towards increased automation of work and Estonia should follow suit. The fact that wages in Estonia are lower than in Western countries is one of the factors that have slowed the development of robotics in Estonia. However, the difference in wages is likely to decrease due to Estonia's economic development in the next decade, so starting to use the opportunities offered by robotics today is important for the international competitiveness of industries. Connections with ICT and exporting developed solutions whenever possible are also important.

Measure: supporting investments in robotics and developing the robotics work of the Innovative Manufacturing Engineering Systems Competence Centre

4 Bottlenecks and new opportunities in medical services and technologies

4.1. E-HEALTH

4.1.1. Estonian e-health solutions are not exported to a sufficient extent

Solution: Estonia has to link service- and IT-innovation. In healthcare, preference should be given to ways of achieving efficiency, quality and people's satisfaction that are based on the broader use of IT. IT developments must be related to the goal of actually changing the provision of healthcare services in Estonia and/or other countries. The state should support IT via programmes/projects that can demonstrate sustainable changes at the level of services (instead of just having/developing new technology). The National Health Insurance Fund should focus on supporting the development of IT-related services.

> Estonia has the potential to become a globally competitive e-health testing platform

The value of using information technology is created primarily in the course of the service provision process (such as a more personal approach, better integration of various services and institutions, remote access, lifelong prevention of health risks on the basis of individual data, reducing unnecessary repetition, intelligent decision-making support with increased participation by patients, constant quality monitoring and feedback). Smart specialisation should support activities that are clearly focussed on the creation of long-term value, not on solving the technical short-term problems of a specific institution.

Estonia has the potential to become a globally competitive e-health testing platform, but this requires further development of the e-health system. One of the bottlenecks is that the information systems of larger hospitals are not combined into a unified system: what Estonia needs is a compatible platform where all patient-related information can be accessed. In addition to IT development, the proposal for genetic mapping of Estonia made in Chapter 4.2 also has high added value, as it would make it possible to expand the e-health system and to create additional opportunities for innovation.

The national e-health system should be structured in such a manner that the private sector can create additional services and products for it – it should be an 'open system'.

Products and services in e-health are often commissioned by the state, which therefore makes exporting the solutions more difficult. Estonia has managed to be innovative in the global sense by implementing several e-health services, such as the digital prescription or e-medical records. It is necessary to systematically analyse the readiness of foreign markets to use similar solutions and to use e-health solutions for the creation of products that are more scalable than services. The state should also be smart when commissioning e-health solutions: it is necessary to develop a national e-health strategy, which lists the services and functionalities whereby using e-solutions is prioritised (e.g. being reinforced by the decisions the state makes). A bottleneck in e-health is that there is no uniform system, which slows down the introduction of e-health solutions by doctors. A compatible platform would accelerate this.

It is likely that many new solutions will have been developed in e-health by 2020, as many areas have great potential for the implementation of technology. Increased mobile monitoring of the health of patients (e.g. with smartphones) and the use of related applications may be given as examples. This is why it is important to monitor technological changes in e-health and test new applications.

Measure: developing a national e-health strategy with a structure that would facilitate exporting e-health solutions.

> it is necessary to develop a national e-health strategy

4.1.2. Insufficient use of the opportunities of personal medicine

Solution: personal medicine, which means developing medicine according to the needs of specific patients, is an area with great potential. It is an area undergoing rapid global development. Estonia can use its ICT, biotechnology and medical strengths to compete in this global research-intensive business – for example, analysing potential fatal risks according to a patient's genome data (see Chapter 4.2.). Estonia also has the preconditions required to develop bioinformatics and health analyses with mobile devices (telemedicine).

Measure: supporting personal medicine projects and connection with the development of a national e-health platform

4.2. BIOTECHNOLOGY

4.2.1. Mapping Estonia's genome data

Solution: analysing health risks on the basis of gene data forms a part of personal medicine. The genome data of ca. 50,000 people have so far been mapped in Estonia, but it is necessary to map a larger share of the population. This would make tests statistically more reliable and create a unique test platform that could benefit the biotechnology sector as well as Estonian healthcare sector on a broader scale. Such an environment would have the potential to attract foreign investors and the pharmaceutical sector, which would increase opportunities for innovation. When we add the desired development of e-health, it would be possible for Estonia to grow into a globally competitive healthcare platform to which very different solutions can be added with development activities, thereby supporting the entire sector. However, an in-depth cost-benefit analysis needs to be carried out about genome data mapping before the implementation of the measure to analyse the following aspects of the project:

a) Economic impact of the project – What is the added value for the Estonian economy and is the project manageable for Estonia?

b) Practical scope of the measures – How many people could be mapped to ensure it is economically optimal and how fast should the movement be between the different stages of the project?

c) Appropriate structure for carrying out the project – What should the structure of the platform be like to make its use attractive to foreign clients?

Measure: support the mapping of genome data (in-depth analysis required before this can be done)

4.2.2. Low commercialisation of biotechnology

Solution: many surveys indicate that the level of biotechnology in our universities can be considered strong. The problem is commercialisation or successful transfer of the knowledge into practical applications. Biotechnology differs considerably from ordinary businesses: the probability of a project failing is very high, but returns are extremely good in the event of success. Projects themselves often take a very long time and require large R&D investments.

Projects themselves often take a very long time and require large R&D investments.

The possible success of biotechnology projects is very difficult to assess in the early stages, which makes giving direct grants from state difficult to assess. This is why the use of financial instruments can be considered more effective. As the investment period of biotechnology projects is long and achieving any turnover often takes years, the most practical financial instrument in this case would be supporting equity investments, e.g. by making biotechnology investments more attractive for (foreign) capital via fund of funds´ support.

Measure: financial instruments and support for bringing in foreign specialists (R&D and business management)

4.3. INSUFFICIENT EXPORT OF MEDICAL SERVICES (INCL. MEDICAL TOURISM)

Solution: as the advantage arising from lower labour costs is decreasing for Estonia, it is necessary to find other advantages in offering services that are attractive to foreign clients. One option is to increase the innovative component in medical services (e.g. personal medicine, telemedicine and the opportunities created by e-health). An additional option for this is to add active support for the exporting of medical services to the existing health services financed by

the National Health Insurance Fund, i.e. provision of services to residents of foreign countries.

An important role in this is played by the 'Directive on Cross-border Healthcare'[7] that will be adopted all over Europe at the end of 2013, as it allows patients to obtain health services in any European Union Member State. This gives Estonia the potential to provide health services to foreign clients, but in addition to the price advantage it is also very important to increase the R&D component in the provision of services. Increased exports of medical services would also be the argument with which to make Estonia again a more attractive working environment for Estonian doctors who have moved abroad.

The specific activities for the development of medical tourism will be disclosed in the document 'Estonian Tourism Development Plan 2014-2020'[8] . In the case of medical tourism it is important to emphasise that it is necessary to move towards services with higher added value. Provision of spa services with less value added should not be the solution from the viewpoint of smart specialisation – the focus should instead be on the provision of licensed medical services.

Measure: developing medical tourism as part of the Estonian Tourism Development Plan 2014-2020 currently being prepared by the Ministry of Economic Affairs and Communications and support for projects aimed at improving the export of medical services

[7] http://ec.europa.eu/health-eu/europe_for_patients/cross_border_healthcare/index_et.htm
[8] http://www.mkm.ee/uudised-3/

5 Bottlenecks and new opportunities of resource enhancement

5.1. INDUSTRY INVOLVED IN ENHANCEMENT OF MATERIALS

The thorough 'Feasibility Study for an Estonian Materials Technology Programme'[9] was prepared in 2011 with the assistance of Finnish researchers and consultants regarding materials science and its industrial applications in Estonia. This document can still be considered the most important base document in the sector and the roadmap for innovation. The five areas with the greatest potential regarding innovation in Estonia's materials industry are highlighted in this analysis. They are also preferred within the scope of smart specialisation:

1. **High-tech materials (solar elements, nanomaterials and earth metals)**
2. **Energy technologies (solar panels, fuel cells and oil shale)**
3. **Micro- and nanoelectronics**
4. **Coating materials and surface treatment**
5. **Measuring, modelling and production technologies**

5.1.1. Insufficient use of scientific competence in enterprise in the materials science sector

Solution: when it comes to the application of R&D in the materials industry, one bottleneck is the limited financial capacity of companies for making investments, as the payback period is often long. There is a need to support companies in making R&D investments so they can implement new technologies and involve the researchers of CCs and universities. Getting support via financial instruments is also important for the sector. Industry involved in materials enhancement has the opportunity to cooperate with another growth area: in knowledge-based construction it is possible to use innovative materials as a result of the development of materials technology (incl. higher energy efficiency). Materials technologies have the potential to provide a lot of assistance to the Estonian industrial sector so that it can move towards the creation of higher added value.

Measure: continuing with the measure 'Supporting Research and Development in Materials Technology' and continuing to support the nanotechnology CC

5.2. KNOWLEDGE-BASED CONSTRUCTION

Knowledge-based construction (one of the sub-parts of which is 'smart building') can be achieved via the following:

- **low energy consumption;**
- **innovative design;**
- **increased use of IT solutions in design, construction and building management; and**
- **use of innovative materials and limited environmental impact.**

Estonia's export potential is most obvious in the area of wooden houses. The sector has further increased its focus on finding export opportunities after the recession of 2008/2009, and today Estonia is the 9th biggest exporter of timber buildings in the world, with a 3% share of global goods trade in this sector. Low labour costs have been one of the advantages here, but moving higher on the value chain is of critical importance for the sector, as labour costs are growing. Globally, knowledge-based construction can become a competitive advantage, which is why it is important to increase the role of such construction. This requires cooperation with other sectors (architecture, construction equipment, materials science etc.). Construction of wooden houses would be one of the ways for Estonia to move towards timber enhancement – the country could use its natural

[9] http://www.mkm.ee/public/inno_15_par.pdf

resource more effectively. Measures: supporting design, finding solutions and monitoring completed buildings with research and development would make the implementation of innovation in construction easier.

5.2.1. Insufficient use of knowledge-based solutions in the export activities of the construction sector

Solution: introduction of new materials and increasingly energy efficient construction can be considered an important change in construction in the next decade. This creates a significant competitive advantage and the opportunity to earn higher margins for companies that manage to put these knowledge-based solutions into practice. This is why it is important to involve scientists in the materials production process, building design and follow-up monitoring to find new opportunities for the creation of added value in the construction process.

> It is necessary to merge the competencies of different parties in the use of the R&D component in production

There are various companies that offer knowledge-based nuances in knowledge-based construction, but they have not been able to merge these into a strong single export product. It is necessary to merge the competencies of different parties in the use of the R&D component in production in order to achieve a greater competitive advantage. Creating a separate CC for knowledge-based construction for the period 2014-2020 would not be reasonable, as launching an CC takes several years. This is why universities and centres of excellence in the area of construction should be in charge of supporting R&D.

Measure: supporting centres of excellence and cluster activities and supporting R&D investments

5.2.2. Insufficient emphasis on knowledge-based construction in objects commissioned by the state

Solution: Many objects have been built with the support of European structural funds in Estonia in the last decade, but the solutions that have often been preferred are those where the initial investment is smaller even though their maintenance costs in the long term may be considerably higher than those of buildings where energy-efficient, long-lasting solutions with little environmental impact are used. In future, it is important that the component of knowledge-based construction is emphasised in the terms and conditions of public procurements. This often means that the maintenance costs of the building are lower and its environmental impact is smaller, and it would also support the development of knowledge-based construction in Estonia.

Measure: supporting knowledge-based construction in public procurements

5.3. FOOD THAT SUPPORTS HEALTH

5.3.1. Insufficient use of R&D in the food industry

Solution: local resources (food) could be used more efficiently and the sector's export capacity could be increased if R&D were given a bigger role in production. As science advances, there is considerable scope for changes in the global food industry, but we must also consider the relatively strict regulative environment that makes marketing innovative products difficult in Estonia. For example, "functional food" has remained a rather narrow area, as meeting the conditions set for functional food in Europe is very difficult. This is why it is more practical to define it as 'food that supports health', instead of focusing solely on 'functional food'.

The research potential of universities has to reach practical applications on the entrepreneurial level in order to raise the sector's competitiveness in Europe and the export potential of Estonia. Biotechnological research aimed at the creation of new solutions in the food industry has great potential.

Measure: supporting applied research in CCs and universities (separate support for applied biotechnological research in the food industry)

5.4. CHEMICAL INDUSTRY

5.4.1. Production with low added value in the oil shale industry – it is necessary to move towards production with higher added value with the help of R&D

Solution: Estonia has a unique natural resource in the form of oil shale. However, it needs more R&D activities in the sector, including an analysis of additional production processes of higher added value. Burning oil shale, which has one of the lowest added values of all possible activities, currently represents a very large share of activities. The waste generated by the oil shale production process should also be more efficiently used. R&D could help find new uses for this waste.

The average age of chemistry researchers in Estonian universities is high, so it is necessary to find younger scientists to allow for continuity. This is why it is necessary to support bringing foreign scientists to universities (including those of Estonian origin who have left). The development of oil shale technologies requires more systematic work to increase the added value created in the course of production.

Measure: additional support for the Oil Shale Competence Centre and supporting oil shale-related applied research in research institutions

6 Further activities and the management structure

Smart specialisation is a new challenge for Europe as a whole and not only in terms of selecting the correct growth areas and activities, but also organising quality implementation and management of smart specialisation.

This analysis shows that the structure of the global economy has changed over the last few decades. An increasing share of research-intensive high-growth enterprise is no longer occurring within a specific sector, but at the crossover points of various sectors. This makes the management of smart specialisation difficult – around ten years ago it was normal for different tasks to be assigned to different ministries, but now most solutions have to be found in cooperation between ministries. Personal medicine, for example, concerns the Ministry of Social Affairs, the MER and the MEAC.

An increasing share of research-intensive high-growth enterprise is no longer occurring within a specific sector, but at the crossover points of various sectors.

This is why the Estonian Development Fund deems it necessary to form a steering committee in the area of smart specialisation, where the participants would be parties associated with the relevant growth areas. The Estonian Development Fund has submitted the relevant proposals with a more specific structure to the ministries concerned.

The following four important processes can be highlighted in relation to the activities associated with smart specialisation on the basis of European source documents and communication with specialists from the European Commission:

1. Monitoring and analysis – analysis should not be one-off; it should be a constant process. Monitoring and analysis must be regularly carried out in the selected growth areas – these areas are developing rapidly and the entrepreneurial environment is constantly changing. It is important that i) analysis and monitoring and ii) management are closely related in the management structure. The input arising from analysis and monitoring should be steered towards the creation of measures as accurately as possible.
2. Creation and monitoring of indicators to measure the success of smart specialisation
3. Involvement – the importance of involving stakeholders has been strongly emphasised in the source documents of the European Commission, and the quadruple-helix model (where consumers, representatives of NGOs etc. are involved) is also recommended in addition to the triple-helix approach (state, enterprise and science).
4. Cooperation – closer cooperation between different parties (such as ministries, universities and companies)

After the completion of the analysis of bottlenecks and new opportunities, it is necessary to continue with a more detailed analysis of bottlenecks in order to structure detailed measures as effectively as possible. The following steps need to be completed for this purpose:

1. More detailed impact of personal medicine and mapping Estonian genome data (practical structure, economic impact etc.)
2. Formulation of the national e-health strategy
3. Detailed work with the MER and the MEAC to make smart specialisation bottlenecks and growth areas compatible with existing strategies
4. Development of smart specialisation indicators
5. Systematic analysis of CCs and clusters: which CCs and clusters should continue operating and which tasks should be set for them?
6. Tying smart specialisation to the Information Society Development Plan
7. Creation of a smart specialisation management structure
8. Monitoring and analysing smart specialisation as an on-going process that would adjust the smart specialisation strategy if necessary (reviewed once a year)
9. Creation of GADIC (see Chapter 2.4. for details)
10. Creation of a comprehensive structure to support research-intensive start-ups (incubators, spinoffs and start-up fund of funds)
11. Restructuring the Spinno programme created to support research institutions

A Annex 1. Entrepreneurs and researchers who participated in the workgroups, took the survey or were interviewed

Ain Aaviksoo	Praxis
Alar Karis	Rectors Conference
Ando Jukk	UPM Kymmene
Allan Martinson	MTVP
Andres Kehman	Akzo Nobel
Andres Metspalu	Estonian Genome Centre
Andres Valkna	Celecure
Bo Henriksson	ABB
Erki Mölder	TREV2 Grupp
Erkki Raasuke	Entrepreneur
Erkki Truve	Tallinn University of Technology
Hallar Maybaum	Federation of Estonian Chemical Industries
Illimar Paul	Logistics and Transit Association
Jaak Vilo	Software Technology and Applications Competence Centre
Jane Paju	Molycorp
Jüri Jõema	ITL
Jüri Kaljundi	Garage48
Kalev Kallemets	Viru Chemical Group
Katre Kõvask	AS Premia Foods
Katri Lingi	Estonian Academy of Art
Kristiina Rebane	Estonian Woodhouse Association
Kristjan Haller	Independent expert from the University of Tartu
Kuldar Leis	AS Premia Foods
Madis Raukas	Osram
Linnar Viik	IT College
Marek Tiits	IBS
Margus Lopp	Tallinn University of Technology
Margus Uudam	Ambient Sound Investments
Mart Saarma	Estonian Biocentre
Mart Ustav	Icosagen
Märt Mathiesen	Nordic Houses
Oliver Väärtnõu	Government Office
Ott Otsmann	Estonian Forest and Wood Industries Association
Peep Siitam	Estonian Development Fund
Peeter Burk	University of Tartu
Pirko Konsa	Tehnopol
Priit Rohumaa	Viru Chemical Group
Rait Hiiepuu	AS Stora Enso Eesti
Raivo Stern	National Institute of Chemical Physics and Biophysics
Raul Parusk	Enterprise Estonia
Riin Ehin	Competence Centre for Cancer Research

Siim Sikkut	Government Office
Sten Tamkivi	Stanford, Skype
Taavi Kotka	Ministry of Economic Affairs and Communications
Taivo Raud	Ministry of Education and Research
Targo Kalamees	Tallinn University of Technology
Tarmo Kivi	Celecure
Tauno Otto	Tallinn University of Technology
Tiina Saron	Estonian Dairy Association
Tiit Paananen	Skype
Toomas Neuman	Protobios LLC
Urmas Sannik	Competence Centre of Food and Fermentation Technologies
Urmas Varblane	University of Tartu
Volli Kalm	University of Tartu
Ülo Kivine	Tere AS
Ülo Parts	Nokia