North Denmark Region RIS3

Expert Assessment

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Executive Summary

NDR is a region with a rich resource endowment which has a position among European regions as an innovation leader. As Denmark it has good governance and strong institutions. Denmark has a well-developed and coordinated national research and innovation policy with good connectivity between the national and regional levels. Thus, it has fulfilled the ex-ante conditionalities for designing and implanting a RIS3 strategy.

An optimal situation for regions will be when regional strongholds, either traditionally or based on research strengths at the regional universities, are found within the same areas which are prioritised at the national level. NDR seems to be in such an optimal situation as the strong areas selected by Growth Forum North Denmark Region correspond to the national prioritised sectors. This put NDR in a very favourable position for designing an efficient RIS3 strategy.

In their regional innovation and development strategy, 'Growth and Balance', the North Denmark Growth region has classified sectors in focus areas of clusters (ICT, food, construction industry, health and life science, and the maritime sector) and of networks (tourism and experiences economies, and energy). Moreover, so called regional front technologies are also identified as being in energy (sustainable energy such as wind, hydrogen, wave, and biofuel), health and life science (medical technology, social innovation) and transport (intelligent transport systems including logistics). These are areas where researchers at Aalborg University are world leading, and, thus, represents strong research environments providing very good opportunities for commercialisation, knowledge based entrepreneurship and new firm formation. In this listing of strong technologies and research expertise also ICT should be included as a traditional stronghold at Aalborg University.

On the other hand the general low educational and competence level in the traditional SMEs in the region, which together with a lack of investments in R&D, represents the greatest threats giving the firms in the region a low absorptive capacity. A low absorptive capacity will have a negative impact on the potential of firms to become more innovative and to link up with national and international collaborators, e.g. in global value chains and production networks. Together with problems of attracting and retaining highly qualified people, especially those graduated from Aalborg University, this challenge must be overcome as part of a successful RIS3 strategy.

The industrial structure of the region represents in many ways a dual structure. On the one hand one finds the traditionally dominating industries, which are either large, process based firms as found within the production of cement, or firms, often SMEs, that depends on an experience based mode of innovation. In a NDR context such firms can be found in the food, construction, maritime and tourism sectors. On the other hand there is the research and knowledge intensive, mostly emergent, sectors, which are based on commercialising research results from Aalborg Universities, and are described as 'regional front technologies' in the regional innovation and development plan.

A key to making traditional industries more innovative and competitive are to strengthen the absorptive capacity of firms relying on an experience based mode of innovation by increasing their research based competence. This is an important strategy for the upgrading of traditional industries, as research has demonstrated that combining experience and research based modes of innovation makes firms perform better. One example of this would be for the food industry to start producing functional food directed to the growing market of obesity in collaboration with biomedical research at Aalborg University and for the maritime sector to link up with the research on intelligent transport systems, logistics and ICT at the university, a collaboration which already has started.

The other strategy of upgrading of traditional industries is to move into high value-added niches. This is a strategy that most efficiently can be realised by mobilising intangible knowledge (branding, design, fashion), combined with a platform approach, i.e. transcending traditional sectors, in the concrete design and implementation. This would normally imply that the firms continue to rely on an experience based mode of innovation, but are able to climb the value-added ladder by introducing new products that has a high element of intangible knowledge to achieve product differentiation and, thus, representing a unique product at the high-end of the global market.

In the regional innovation and development plan such possibilities of applying a platform approach based on combining knowledge, including intangible knowledge, is among the proposals with reference to the food, tourism, and experience based economy sectors. Here the potentials exist of combining food (gastronomy) with nature and culture to produce a tourist product that can be customised to the preferences of demanding international customers and create a high level of value added. Good Nordic examples of such upgrading strategies in tourism is the Ice Hotel in Northern Sweden with 30.000 guests every season (November-April) and The Santa Claus Village in Rovaniemi in Northern Finland which attracts visitors by advertising the possibility of crossing the 'magical' Arctic Circle in sledges drawn by reindeers.

Both in national plans as well as in the regional innovation and development plan there are strategies for dealing with the problems connected to the low educational and competence level and the lack of R&D investments in many Danish firms, especially in SMEs in traditional industries. On the national level one finds mobility plans, i.e. subsidising the hiring of academic work force in firms not previously employing this category of workers as well as financial support for SMEs to acquire research based knowledge through collaboration with universities. At the regional level there is the focus on firm oriented competence development and continued education, the role of the Growth House as well as the matchmaking institution where Aalborg university play a key role. A stronger focus on the specific needs referred to above to upgrade the traditional industry to become more innovative, value-adding and competitive, especially by adding intangible knowledge, should guide the design and implementation of the strategies of competence development in the RIS3 strategy. The fact that humanities at Aalborg university offer a master degree in Experience Design might be very instrumental in this context.

The other part of the dual industrial structure of the NDR is the research and knowledge intensive, mostly emergent, sectors, which are based on the regional front technologies within energy, health and life science, and transport (including logistics and the maritime sector). These areas all represent strong research milieus at Aalborg university. In addition ICT should be added to these regional front technologies as it has been and still is both a research stronghold and an important industrial sector (although not as important as before) as well as a general purpose technology to increase productivity in other sectors. These technologies are found in firms which are part of regional clusters and network. In some of these areas, such as medical technology, energy efficiency and embedded software, wireless communication, and sustainable energy (especially connected to windmills), the research at the university are world leading.

Applying a R&D based strategy is a very costly development and differentiating strategy, with a high failure rate and with a long term perspective of producing positive results with respect to new firm growth and job generation. However, given the existence of the strong research base in key technologies which take on future societal challenges regionally, nationally and globally, this research capacity and access to the best knowledge internationally should of course be exploited in an optimal way. The traditional focus on a R&D based strategy, manifested in strong science and technology policy at the national level in Denmark, represent an important asset in implementing such a strategy, especially as the regional front technologies are part of national prioritised technologies, too. If the available national funding for developing these technologies are mobilised together with accessible EU funding through Horizon 2020 and other relevant programs in a smart way, a

considerable amount of funding should be available for the commercialisation of these technologies, leading to new firm formation, generation of high qualified jobs, and the attraction of Foreign Direct Investments, especially R&D units from international corporations, which will take advantage of connecting up to leading research milieus at the university and the accessibility to a highly qualified labour force graduated from Aalborg university. In many ways, these resources are so far only marginally exploited in the region.

Another strategy for R&D based clusters, in NDR especially the ICT cluster, is to diversify by combining knowledge. A good example of such a strategy can be found in one of the 'Vanguard' regions, Scania, where the strong ICT cluster, originally established in 1983, has developed towards becoming a New Media and Digital Design, which was established in 2006 in Malmö. The ICT cluster was located in the IDEON science park in Lund, where Ericsson developed software for mobile phones in close cooperation with Lund Technical University. The New Media cluster builds on combining the existing competences in mobile communication based on R&D with new competences in media and design drawing on intangible knowledge in collaboration with the local university college in Malmö. In this way the New Media cluster takes advantage of the new growth trajectory in the mobile phone industry, where the largest growth potential lies in design oriented software development (e.g. mobile phone apps). Small steps in the same direction are also taking place in NDR by combining competences in ICT and experience design.

One way to increase the development and exploitation rate of the front technologies is to make public procurement for innovation (PPI) a central instrument. Partly the whole area of health and welfare are confronted with huge societal challenges in general due to the aging of society, which requires these sectors to operate in a smarter way, and partly specifically the building of the new university hospital in the region close to the university, offers a big opportunity of using PPI to support the development of these technologies. In fact, all of the front technologies (energy, health and life science, and transport/logistics as well as ICT) could be stimulated by an effective use of PPI. As the public sector is the large, critical and demanding customer in this area, and the Region has the main responsibility for the health area, the Region has a unique possibility of influencing the development and exploitation of these front technologies. The Region and its Growth Forum should give this a high priority, and perhaps establish an agency with the operational responsibility of implementing such a policy.

To succeed with a R&D based development strategy, there will be a substantial need of talent, which is one of the elements of the regional vision. Thus, there will be an increased need of attracting students to Aalborg university from the region, the country and internationally as well as to retain them in the region, which is dependent on the presence of enough high qualified jobs. In addition, one should contemplate the adding of a fourth 'T', for Tolerance, to the existing three (talent, technology and tradition) that constitute the vision for NDR as an innovative region. The SWOT analysis showed that recruiting and retaining high qualified labour could be considered a threat to the future development of the region, which should give an incentive to focusing more on what is called 'people climate' in addition to 'business climate'. The most important elements constituting a good 'people climate' are openness, diversity and tolerance. The relevant point in this connection is the argument that if cities were attractive for the creative class, due to a favourable people climate, job would follow people, and not vice versa, which is the normal situation, that people follows job. Promoting the people climate would in the NDR context only be a relevant policy for the city of Aalborg, however, with respect to recruiting and retaining the creative class, Aalborg should be looked at as an asset for the whole of NDR. Thus, from a NDR perspective, attracting such people to Aalborg should be better than exporting highly qualified people to Copenhagen.

However, to successfully promote new path development, either in the form of path renewal (regional branching based on related variety) or new path creation based on commercialisation of research based knowledge, will require concrete and specific action lines. At the regional level what

seems to be lacking is a higher capacity of formulating specific and concrete action lines. This is a major challenge in the process of designing and implementing a productive RIS3 strategy for regional development in NDR. Here a governance reform is proposed, which implied a division of labour between the Growth Forum and external organisations with respect to which aspects of the regional innovation and development plan the respective levels would be operationally responsible for. Using the RIS terminology the Growth Forum could be responsible for the innovation system broadly defined, securing that the NDR becomes a learning region on the one hand. The operational responsibility for a regional innovation system narrowly defined, i.e. the systemic interaction between the subsystem of knowledge generation or exploration, mainly found at the university, and the subsystem of knowledge exploitation represented by firms in clusters and networks, could on the other hand be decentralised to triple helix based constellations of the most important stakeholders from the university, industry, represented in strong regional clusters of firms based on the regional front technologies, and public sector representatives. Such consolidated clusters should have a clear mandate of promoting growth and jobs, still though with the overall strategic leadership located in the Growth Forum. This would provide responsible bodies, which are better equipped to make the necessary strategic decisions required to achieve a successful development of research and knowledge intensive, emergent sectors, as they would be more directly involved in innovation and industrial development. Adopting such a governance structure would imply that the region would come closer to using an innovation system approach for its innovation policy. Such a change in governance structures might make it easier to reach the necessary strategic decisions of how to allocate scarce human and financial resources in the best way to most efficiently promote the development, exploitation and diffusion of the regional front technologies to achieve new firm formation and job generation in the research and knowledge intensive sectors of strategic importance for securing the future innovativeness, competitiveness and welfare of the NDR.

1. Introduction

The primary purpose of this expert assessment is to examine if the NDR is on the road to designing and implanting a Smart Specialisation strategy for regional development, to evaluate the potentials for a successful RIS3 strategy in the region, and to present recommendations for how this could best be achieved. According to Annex 1a in the contract, the Commission has, as part of the Europe 2020 strategy, set out a comprehensive innovation strategy for Europe to enhance Europe's capacity to deliver smart, sustainable and inclusive growth.

The concept of smart specialisation aims at exploring possibilities of promoting competitive advantage based on the unique characteristics and assets of a country and region. This should be achieved by collective efforts of regional stakeholders mobilising resources through strengthening regional innovation systems in order to optimise knowledge flows and diffuse the benefits of innovation throughout the entire regional economy.

Smart specialisation is one of the conditions for well-performing national and regional research and innovation systems. It is a key element of the European Commission's proposal for a reformed cohesion policy as an ex-ante conditionality for the use of ERDF in the next Structural Funds programming period 2014-2020. This means it is a pre-condition related to the effective use of the EU funds, which should be fulfilled by the time an Operational Program is approved.

The assessment was commissioned by DG Regio and has been conducted by Professor Bjørn Asheim. All interviews, with the exception of one skype discussion with representatives from the third mission department at Aalborg University and one telephone interview, were conducted on a face-to-face basis in February and March 2014. In addition, I participated in the maritime cluster in Frederikshavn. The interviews with senior figures in the regional administration, industry, cluster and network organisations, and at the university could not have been arranged without the cooperation and generosity of the administration of the NDR. Here I am especially grateful to Tommy Hebsgaard Søltoft Henriksen, Morten Lemvigh and Henning Steffen Christensen from Regional Development in the NDR for their assistance and helpfulness in organising the interviews as well as for their interest in my work and willingness to engage in discussions and for answering my many questions. I would also like to extend my gratitude to Frank Elholm who has been a supporting person in DG Regio. Without the help of these persons, and the many other which I interviewed, this report would have been much more difficult to write, and highly probably much less relevant and interesting to read. For the sake of transparency and the public record the names of the interviewees and their organisations are listed in Appendix 1.

We now turn to the substantial content of the report, which starts with a short presentation of Smart Specialisation and a similar short overview of complementary theoretical perspectives on Smart Specialisation, where especially the Constructing Regional Advantage approach will be discussed. Then the regional and national context of NDR is described and analysed, before assessment, feed-back and suggestions on the dimensions constituting the assessment grid in Annex 1b is provided.

2. What is Smart SprIecialisation – a short presentation and discussion

Smart Specialisation (RIS3) is a strategic approach to an innovation based policy for Regional Development. It will be the basis for European Structural and Investment Fund interventions in R&I as part of the future Regional and Cohesion Policy's ambition to the European 2020 jobs and growth agenda. SS is being promoted by DG Regio as the basis for the next generation of Structural Fund programs post-2014. The presence of a SS strategy is a requirement as part of the next conditionality framework for a member state wishing to use its European Regional Development Fund (ERDF) for innovation activities. This is why all member states in EU have to design and implement this strategy to receive structural funds in the coming years towards 2020. Thus, it is of great importance that this strategy is fully and correct understood, not the least because the choice of key words (i.e. 'specialisation' and 'entrepreneurial discovery') may lead policy makers and practitioners to make false interpretations and draw wrong conclusions.

SS is basically not about 'specialisation' as is known from previous regional development strategies, i.e. Porter based cluster strategy, but about diversification, or diversified specialisation/specialised diversification. Thus, 'smart diversification' would have been a better description of the strategy. What it means is that regions should identify areas - or 'domains' as the SS strategy prefers to call it - of existing and/or potential competitive advantage, where they can specialise in a diversified way compared to other regions. A SS strategy implies maximising the knowledge-based development potential of any region, with a strong or weak R&I system or with a high-tech or low-tech industrial structure. Moreover, regions should diversify their activities based on existing strengths and expertise by moving into related areas through regional branching. As an example regions (e.g. in Southern Europe) where tourism is a dominating sector could be used as an illustration. Such regions should not all just go for a plain SSS (sea, sand and sun) strategy, which would end up in a downward spiral of price competition (i.e. the low road strategy), but should combine the quality of the natural endowment with other attractions such as art, culture, gastronomy etc., and/or combine natural, historical and cultural attractions with medical treatment by offering health tourism, in a platform based policy which would allow the local tourist product to travel up-market through a knowledge based process of product differentiation (i.e. a high road strategy).

The 'smart' in the SS strategy refers to the way these domains of competitive advantage should be identified, which is through what is called 'entrepreneurial discovery', to

secure specialised diversification across related technologies. Here lies another source of potential misunderstanding, as it easily will be thought of as identical with the traditional entrepreneur resulting in a policy focus on on-off firm formation. However, it is underlined in the writings on SS that 'entrepreneurial' should be understood broadly to encompass all actors (including individual entrepreneurs), organisations (including firms and universities through intrapreneurship, knowledge based entrepreneurship and spin-offs) and agencies (technology transfer offices and regional development agencies) that have the capacity to discover domains for securing existing and future competitiveness. Perhaps Van der Ven's description of 'the entrepreneur' as one type of leadership of the 'innovation journey' comes close to what is meant with entrepreneurial discovery in the SS strategy. He talks about the entrepreneur as a role likely to be played by a core network of interacting actors from the regional innovation system (RIS), comprising a limited number of firms, universities, public research organisations and government institutions (Van der Ven, 1999). Given such a broad interpretations it might perhaps have been preferable if the process of identification of growth areas was called 'innovation discovery' to avoid that the systemic nature of innovations and, thus, the importance of a system approach to regional innovation policies is ignored as well as failing to understand the role of government in driving innovation, which is central to a system approach (Asheim and Gertler, 2005; Asheim et al., 2011a).

Some of the stronger regions in Europe with respect to R&D, innovativeness and competitiveness have formed what is called 'the Vanguard Initiative for new growth by Smart Specialisation'. In the presentation of the SS strategies of these regions a system approach is clearly present, e.g. in the cases of the Basque Region, Scania, and Zuidoost-Nederland, which talks about innovation system, innovative clusters, and triple helix cooperation, all examples of a system approach to innovation and regional development.

Some of the ideas in the SS strategy are derived from the Constructed Regional Advantage (CRA) approach which stem from work that started in Brussels in an Expert Group appointed by DG Research of the EU commission and where this expert had a leading part. In 2006 DG Research launched the final report on 'Constructing Regional Advantage' as the new way of taking on and combating challenges and problems of globalisation for European regions (Asheim et al., 2006). Examples of such diffusion of ideas are the recognition that knowledge and innovation are the driving forces of economic development, that history matters which underlines the importance of path dependency, that the process of specialised diversification should build on related variety, that a combined top-down/bottom-up approach should be applied in the implementation of the strategy giving a key role to local and regional stakeholders, that both approaches have a stronger focus on demand than supply for driving innovation, an appreciation of a 'no one-size fits all' policy, and, finally, being in favour of public-private collaboration (Boschma, 2014a). As there is more to gain by drawing from this work, especially the knowledge-base approach, which represent a theoretical cornerstone in

the CRA approach (Asheim et al., 2011b), we now turn to a short presentation of this approach in the next section to provide more theoretical informed perspectives on how to design a SS strategy.

3. Theoretical perspectives on Smart Specialisation – an overview of key concepts

Constructing regional advantage means promoting competitive advantage through product differentiation creating unique products. While building on the lessons from the dynamic principle of the theory of competitive advantage (Porter, 1998) as well as of the innovation systems approach (Lundvall, 2008) emphasising that competitiveness can be influenced by innovation policies and supporting regulatory and institutional frameworks, the constructed advantage approach especially recognises the role of a proactive public-private partnership and impact of the public sector and public policy support by acknowledging to a greater extent the importance of institutional complementarities in knowledge economies. This approach represents an improved understanding of and response to the problems of system failures caused by lack of connectivity in regional innovation systems.

Increasingly there is a strong agreement that innovation is the key factor in promoting competitiveness in a globalising knowledge economy. Competition based on innovation implies choosing the high road strategy, which is the only sustainable alternative for developed, high-cost regional and national economies as well as for the future of developing economies. For a long time such a strategy was thought of as being identical with promoting high-tech, R&D intensive industries in accordance with the linear view of innovation. More and more the recognition has evolved that a broader and more comprehensive view on innovation has to be applied to retain and develop competitiveness in the heterogeneity of European regions, i.e. that all drivers of innovation (both supply and demand side (user, market, demand (social innovation)) as well as employee driven innovation) have to be integrated into an overall approach to innovation policy. This requires a differentiated knowledge base perspective (i.e. distinguishing between analytical, synthetic and symbolic knowledge) to be fully accommodated (Asheim and Gertler, 2005; Asheim, 2007). Such a broad based innovation policy is in line with the innovation system approach of defining innovation as interactive learning combining an STI (Science, Technology, Innovation) and a DUI (Doing, Using, Interacting) mode of innovation (Lorenz and Lundvall, 2006).

At a regional level – in particular – a 'no size fits all' approach has to be adopted due to the heterogeneity of European regions (Tödtling and Trippl, 2005). Thus, a Porter perspective was adopted arguing that all industries can be innovative and that the high-tech – low-tech distinction is not relevant at a sectoral level as a point of departure for innovation policies as R&D intensity is not the same as innovation capacity; knowledge is a far broader concept than R&D. This implies that regional advantage has to be constructed on the basis of the uniqueness of the capabilities of firms and regions,

which, however, in a globalising economy becomes more and more knowledge intensive (Asheim et al., 2006). Secondly, that regions and countries should base their competitive strategy on industries they traditionally have been doing well in; i.e. building on their technological path dependency to achieve positive lock-in effects or path extension. The existing industrial structure of regions will also in most cases represent the main source of path renewal in the form of regional branching based on related variety to secure future competitiveness and to make regions resilient (Boschma, 2014b).

Knowledge processes have become increasingly complex in the globalising knowledge economy. The binary argument of whether knowledge is codified (i.e. knowledge that has been stored in certain media and can readily be transmitted to others) or tacit (i.e. knowledge that is difficult to transfer to another person by means of writing it down or verbalising it) becomes too simplistic to accommodate this increased complexity and provide an adequate understanding of knowledge creation, learning and innovation. Thus, a need to go beyond this simple dichotomy can be identified. One way of doing this is to make a distinction between 'synthetic', 'analytical', and 'symbolic' types of knowledge bases, which partly transcends the tacit-codified dichotomy arguing that the two forms of knowledge always co-exist but in different combinations, and partly emphasises that all types of economic activity can be innovative but that the modes of innovation differ, thus, transcending the high tech-low tech dichotomy (Martin and Moodysson, 2013). As this threefold distinction refers to ideal-types, most activities are in practice comprised of more than one knowledge base. However, one knowledge base will represent the critical knowledge input which the knowledge creation and innovation processes cannot do without. New combinations of knowledge bases, especially when symbolic knowledge is involved, seem to become increasingly important as a source of new path development (i.e. path renewal and path creation).

An analytical knowledge base refers to economic activities where scientific knowledge based on formal models and codification is highly important. Examples are biotechnology and nanotechnology. University-industry links and respective networks are more important than in the other types of knowledge bases. Knowledge inputs and outputs are in this type of knowledge base more often codified than in the other types. The workforce, as a consequence, needs more often some research experience or university training. Knowledge creation in the form of scientific discoveries and (generic) technological inventions is more important than in the other knowledge types, and, consequently, innovations are science-driven. Partly these inventions lead to patents and licensing activities. Knowledge application is in the form of new products or processes, and there are more radical innovations than in the other knowledge types. An important route of knowledge application is new firms and spin-off companies which are formed on the basis of radically new inventions or products.

A synthetic knowledge base refers to economic activities, where innovation takes place mainly through the application or novel combinations of existing knowledge. Often this occurs in response to the need to solve specific problems coming up in the interaction with customers and suppliers, and, thus, innovations are user, market, and demand driven. Industry examples include plant engineering, specialised advanced industrial machinery, and shipbuilding. University-industry links are also for this knowledge base important, but more in the field of applied research and development than in basic research. Tacit knowledge is more important than in the analytical type, in particular due to the fact that knowledge often results from experience gained at the workplace, and through learning by doing, using and interacting. Compared to the analytical knowledge base, there is more concrete know-how, craft and practical skills required, which is provided by technical universities, polytechnics, or by on-the-job training. Overall, this leads to a rather incremental way of innovation, dominated by the modification of existing products and processes.

Symbolic knowledge is related to the creation of meaning and desire as well as aesthetic attributes of products, such as designs, images and symbols, and to its economic use. The increasing significance of this intangible type of knowledge is observed by OECD (2013) mentioning e.g. design as a new source of growth as part of firms' knowledge-based capital as well as through the dynamic development of cultural production such as media (film making, publishing, and music), advertising, design, brands and fashion. In cultural production the input is aesthetic rather than cognitive in quality. This demands rather specialised abilities in symbol interpretation and creativity. This type of knowledge is often narrowly tied to a deep understanding of the habits and norms and 'everyday culture' of specific social groupings. Due to the cultural embeddedness of interpretations this type of knowledge base is characterized by a distinctive tacit component and is usually highly context-specific. The acquisition of essential creative, imaginative and interpretive skills is less tied to formal qualifications and university degrees than to practice in various stages of the creative process, however, also this knowledge base has become increasingly more knowledge intensive.

4. The National and Regional Context – a short overview of the present economic situation and innovation policy

Denmark is a country of good governance and strong institutions which is manifested in a high degree of organisational and institutional thickness on all spatial levels, national, regional and local. According to Charnon et al. (2013) Denmark and its regions are among the leaders in the EU with respect to good governance. Through a dense networking horizontally and vertically these organisations are very well connected, which based on a strong presence of social capital of the bonding as well as the bridging type and a high level of trust supports a tradition of strong collaboration. This governance structure does also characterise the way the research and innovation system is constructed. Thus, to

understand the regional context in NDR for designing and implementing a RIS3 strategy, research and innovation policy at the national level and its relations to the regional level has to be shortly introduced as the framework for a RIS3 strategy.

Denmark is one of the best performing economies in the EU and has a high ranking on various international innovation and competitiveness rankings and is also one of the top performers in Europe with respect to the share of GDB allocated to R&D following Finland and Sweden in the third position. As one of the few countries Denmark managed to fulfil the EU's 3% target for R&D as percentage of GDP.

In spite of this, and, thus, quite surprisingly, Denmark is the Nordic country whose economy has suffered most during the last global economic and financial crisis especially with respect to having one of the lowest productivity growth rates in Europe (only Italy had a lower one) and heavy loss of industry employment. Now the situation has improved and Denmark seems to be on the right track again leading back to its previous good performance. One among several explanations of this might be found in the research and innovation policy.

Traditionally, Denmark's R&I policy has been dominated by a linear thinking which had its base in the fact that the universities always have been a strong pillar in the Danish system (Fagerberg and Fosaas, 2014). This has been manifested in Denmark pursuing a science and (especially) technology policy supporting the high-tech (e.g. pharmaceutical) and other knowledge-intensive industrial sectors more than an innovation policy. This can be illustrated by the word 'innovation' first entry into the Danish policy scene in 2002 by the establishment of the Council for technology and innovation. Thus, innovation thinking more broadly defined has not been very influential in Danish policy discussion until recently, and has not been considered as a central issue (at least until recently and even if it for some years has been part of the name of the ministry) compared to other Nordic countries (especially Sweden and Finland), which also is manifested in the fact that Denmark still does not apply an innovation systems approach in its research and innovation policy in stark contrast to Sweden and Finland (Lundvall, 2008). Thus, the Danish policy has been quite strongly biased towards a supply side policy and promoting a R&D based innovation strategy. One example of this is the (linear) strategy of increased research-industry collaboration through the 'from research to invoice plan' (not innovation as most foreign readers think), which partly should increase the use of new research results in industry to promote innovation and competitiveness and partly should produce additional income for the universities. In the new innovation policy strategy from the government this has been balanced with a new and strong focus on demand side factors, primarily large global and national societal challenges, as drivers of innovation. This change in policy is among other factors based on evaluations of existing policies, where the linear approach mentioned above was criticized for not being interactive enough.

Given Denmark's industrial structure with a dominance of SMEs of which the majority is neither R&D intensive nor very innovative, a supply driven policy is not the most adequate. Thus, even if the quite comprehensive system that was established in the first ten years of the 2000s contained many elements that had the potential of improving the innovation capacity of the SMEs based on the experience based DUI (Doing, Using, Interacting) mode of innovation, such as mobility plans, network and cluster initiatives, technology brokers etc., it seems not to have had the planned effect of enabling SMEs to make more use of research based input and cooperation with universities to embrace (also) a R&D based STI (Science, Technology and Innovation) mode of innovation. One main reason for this is probably the fragmented structure of the R&I system with the ministry, three different councils and other agencies and organisations all having responsibility for their part of politics.

In a reform carried out by the Ministry for Science, Innovation and Higher Education and implemented from April 1st this year, the three councils have been merged into a Danish Innovation Fund (InnovationFonden, Denmark), promoting research, technology and growth in Denmark. Thus, for the first time the comprehensive arsenal of policies and politics previously spread around numerous councils and agencies are now gathered in the same organisation, which provides an organisational platform for designing an integrated, broad based innovation policy. This can simplify and streamline the available support forms, avoid duplication of policies as well as secure synergy effects so to better support both the STI and the DUI modes of innovation as well as their combination and more efficiently pursue the overall goals of the research and innovation system of making Danish firms and regions more innovative and competitive in the global economy. Still, though, an innovation system approach is not applied, and instead the tools are cluster and networks (which more or less are treated as the same in contrast to other Nordic countries which have cluster programs designed as (regional) centres of expertise), partnerships, and consortiums between universities, industry and often the public sector, generally of a duration between 3-5 years. In contrast most centre of expertise programs in VINNOVA – the Swedish Governmental Agency for Innovation System – have a ten years duration and is also much better funded.

The Danish government has implemented a 'growth plan' to strengthen productivity and competitiveness of Danish firms as a strategy to implement the R&I policy as concrete politics, building on the recommendations from growth teams. To strengthen the general conditions for increased economic growth the government established eight growth teams. The growth teams, which are constituted as a triple helix constellation, should recommend how to improve the conditions for growth within specific sectors, which are:

- The maritime sector ('the blue Denmark')
- Creative industries including design
- Water, bio- and environmental sectors
- Health and welfare sectors

- Energy and climate
- Tourism and experience based economies
- Food
- ICT and digital growth

These growth teams cover many of the same areas and sectors as is prioritised in the new INNO+ catalogue, which presents areas for strategic investments in innovation, and which probably will be an important basis for the priorities of the Danish Innovation Fund. The INNO+ catalogue is a result of a comprehensive process by a broadly mobilised group of stakeholders from the Danish society and does not directly represent the policy of the government, i.e. a typical procedure in the networked, representative and coherence oriented Danish society. The INNO+ catalogue has the following prioritised areas, which will represent the basis for social partnerships on innovation with a 3-5 year perspective as an important element of the new innovation policy:

- Innovative transport, environment and urban development
- Innovative food production and bio economy
- Innovative health solutions
- Innovative production
- Innovative digital solutions
- Innovative energy solutions

The point of listing these prioritised sectors and areas is that in order to have an efficient RIS3 strategy the prioritised areas at the regional level should reflect the priorities at the national level as the majority of all research and innovation support will be directed to these prioritised areas. Thus, the optimal situation for regions will be when regional strongholds, either traditionally or based on research strengths at the regional universities, are found within the same areas which are prioritised at the national level.

NDR seems to be in such an optimal situation as the strong areas selected by Growth Forum North Denmark Region, which appointed by the Regional Council and representing a triple helix based coalition of stakeholders, is the main responsible agency for designing a regional innovation and development strategy. According to this strategy, presented in the document 'Growth and Balance' from 2010, these strong areas are the following ones:

- Tourism and experience economies
- Construction industry
- Energy
- Food
- Health and life science
- ICT
- Intelligent transport (including logistics)

- Maritime sector

As can be seen, these prioritised areas fell under either one of the growth teams or the INNO+ selection or under both of them (6 of the 8 prioritised areas). This, given that NDR actually has strengths in these areas, put the region in a very favourable position for designing an efficient SS strategy.

NDR is a well performing region that has improved its competitive advantage rapidly during the last years. According to the European Regional Innovation Scoreboard from 2014 NDR belongs to the innovation leaders among European regions, a position it also held in the 2010 ranking. The region performs well with respect to R&D expenditures in the business sector, SMEs innovation in-house, as well as SMEs introducing product and process innovations. Poor performance is found in non-R&D innovation expenditures and EPO patent application, while the performance on other indicators is average. Quite logically the most innovative regions, which are characterised as innovation leaders, are typically found in the most innovative countries (e.g. in addition to Denmark, Sweden, Finland, Germany and Switzerland), which gives another reason for this report's close look at how the national R&I system is constructed. In the benchmarking tool, which is available at the RIS3 platform, the regions which NDR could use in a benchmarking exercise is Southern Sweden (the region of Scania) and the Central Denmark region, with which NDR already has a close cooperation.

In their regional innovation and development strategy, 'Growth and Balance', the North Denmark Growth Forum has classified sectors in focus areas of clusters (ICT, food, construction industry, health and life science, and the maritime sector) and of networks (tourism and experiences economies, and energy). Moreover, so called regional front technologies are also identified as being in energy (sustainable energy such as wind, hydrogen, wave, and biofuel), health and life science (medical technology, social innovation) and transport (intelligent transport systems including logistics). These are areas where researchers at Aalborg University are world leading, and, thus, represents strong research environments providing very good opportunities for commercialisation, knowledge based entrepreneurship and new firm formation. In this listing of strong technologies and research expertise also ICT should be included as a traditional stronghold at Aalborg University.

In a Danish context NDR has improved its relative position during the last years. Looking at productivity NDR had the highest among Danish regions up from the bottom position in 2008 (here it is, though important to remember that in a European context Denmark has suffered from a very low productivity growth). The labour force has been stable in the period 2004-2008, however, it has not grown as fast as in some other Danish regions. The worrying element in this picture is outmigration of highly educated people, often graduated from Aalborg university, which the region has problem in retaining due to lack of jobs for highly qualified workers. Still looking at framework conditions for

growth the region is in a middle position with respect to human capital in Denmark. Concerning innovation it only ranks as No. 4 of the 5 regions, and with respect to application of new technology as No. 4. The position looks better when looking at level of entrepreneurship where it only ranks after Copenhagen, the capital region, however, when measuring the performance of entrepreneurship the NDR has a bottom position. Looking at sectors contribution to economic growth the most important sectors are ICT, construction and medical technology/health which together represent more than 50% of the growth. Of special importance is the ICT sector which contributes with 21% of the total increase in growth in the period 1994-2008 mainly due to increased productivity and not job growth. This is 3 times its share of the regional economy. Tourism and food production, which traditionally have been important sectors in the economy of NDR, has had either a zero or a negative growth in this period, while sectors related to energy and environment have had a very low growth rate of 2%.

Some of the explanation for the ranking of NDR among the Danish regions can be found in the SWOT analysis carried out by the Growth Forum. As main strengths a relative high productivity level, strong clusters in regional focus areas, a good collaboration between firms in the region on R&D, and a relative high share of the young population who gets a secondary education are mentioned.

Looking at weaknesses a general low educational and competence level, a lack of investments in R&D in local firms, a limited exchange of knowledge between the public and private sector (with the exemption of Aalborg University which performs very well in this respect with a comprehensive cooperation with both the private and public sectors), too few entrepreneurs creating fast growing new firms, and lastly, a limited international orientation in the regional industry are highlighted. These weaknesses are mostly found in SMEs in the traditional sectors, and might explain the poor performance of the region with respect to non-R&D innovation expenditures, which could be used as an indicator of the DUI mode of innovation dominating in such firms.

Concerning opportunities an increased understanding of the importance of collaboration as an answer to regional challenges is noted. Moreover, there is a good supply of important educations at most levels. Strong technological basis within ICT and energy is also mentioned as well as a growing understanding of the importance of strengthening innovation and globalisation.

As a major threat a falling population size and, consequently, a shrinking labour force is referred to. Linked with the above threat are difficulties in retaining and recruiting high qualified labour force. Traditional, dominating industries such as tourism and construction are under pressure, which is also considered a threat. And lastly, increasing inequalities between centre and periphery is mentioned which are caused partly by Aalborg's dominating position and partly by the peripheral location of the region as such in a Danish context.

Of the weaknesses and threats the ones representing the largest challenges for the possibilities of designing and implementing a productive RIS3 strategy, that also will produce expected results, are the low educational and competence level in the firms in the region, which – even if continuously improving over the last years - together with a lack of investments in R&D still gives the firms in the region a low absorptive capacity. Absorptive capacity, which is a result of the general educational level in the firm as well as of their R&D efforts, is of strategic importance for firms' capacity of creating, accessing, adapting and using new knowledge for innovation. A low absorptive capacity will have a negative impact on the potential of firms to become more innovative and to link up with national and international collaborators, e.g. in global value chains and production networks. Partly the low absorptive capacity also explains the limited international orientation of regional firms. Together with problems of attracting and retaining highly qualified people, especially those graduated from Aalborg Universities, this challenge must be overcome as part of a successful RIS3 strategy. Key to this is an increased focus on and efforts put into increasing the general and specific educational level, where Aalborg University, regional colleges as well as life-long learning activities both by labour market agencies and firms represent strategic actors and initiatives. As mentioned in one evaluation report, establishing an Academia for life-long education might be one way to go.

After this background section on the national and regional framework conditions for designing and implementing a RIS3 strategy in NDR, we now turn to the specific questions of the assessment grid to be addressed by this expert. The assessment is structured according to the guidelines set out in Annex 1b of the DG Regio contract, which requires an evidence-based response to 8 key questions.

5. Assessing, providing feed-back and suggestions on the dimensions constituting the assessment grid in Annex 1b in the contract (points 1-8)

5a) Is the strategy based on an appropriate stakeholder involvement? How does it support the entrepreneurial discovery process of testing possible new areas?

NDR does not yet have a single RIS3 strategy document, but it is working on producing one as part of the new regional innovation and development strategy, which this expert assessment will deliver input to (see Question 8 for a discussion of the plans of the NDR). However, Denmark has already fulfilled the ex-ante conditionalities required by EU, confirming that Denmark has the basic framework conditions necessary for designing and implementing a RIS3 strategy, and that its R&I policy contain all the key elements of a RIS3 strategy. Thus, what is still lacking for the Danish regions, and also for NDR, is to produce a regional development plan based on the RIS3 strategy.

The basis for a RIS3 strategy for Danish regions is the large number of national and regional strategies presented in the last section. The regional growth forums are

together with the relevant ministries, especially the Ministry for Science, Innovation and Higher Education and the Ministry for Business and Growth the main responsible actors/agencies for the implementation of a RIS3 strategy. As also described in the previous section, the design and implementation of Danish R&I policies take place through a broad, networked based involvement of all relevant stakeholders, typically representing a triple helix constellation, both on the national and the regional level. The Danish system does not only have strong horizontal connectivity between the various actors and agencies but also vertically securing that the different spatial levels are connected and interacting. This strong coordination secures that the policy initiatives at the various spatial levels and between different agencies pull in the same direction relevant for designing and implementing a RIS3 strategy.

Thus, all relevant actors/agencies on the national and regional level from Ministries via industrial associations and labour market organisations at the national level to regional agencies and representatives from industry, trade unions and municipalities at the regional level have been involved in the process. This process is to a large extent based on meetings with the relevant groups, workshops and consultations based on draft proposals. This procedure has been adequately described in the relevant documents.

As said above, at the regional level the Regional Growth Forum is responsible for the RIS3 process. In the presentation of the Danish R&I policy in the previous section, it was evident that this policy is a result of strategic planning and works with a priority-setting based on the identification of existing and future areas where Denmark has or can obtain competitive advantage. The entrepreneurial discovery process in this system is, thus, of a very collective nature. At the regional level the Growth Forum is responsible for promoting and handling the applications for funding to support industrial development from different regional actors ranging from the university, cluster and network organisations, individual firms and municipalities in collaboration with local firms. The funding derives from specific funding for regional development from the Regional Council as well as from EU's Regional and Social funds. The Growth Forum is, thus, not directly involved in the entrepreneurial discovery process. This role is left to the actors and agencies that apply for funding (see above). One of the strong research milieus at Aalborg University, e.g. in medical technology, has established a research and business park, Eir (empowering industry and research), which is the only environment in Europe where biomedical technology and medical basic and applied research cooperate closely with the health sector (clinical research) and the business community. Another example is the cluster, BrainBusiness ICT North Denmark, which is a large private-public partnership within the ICT area, which traditionally has been a research stronghold at Aalborg University. The aim of Brain Business is to support and develop the ICT cluster in North Denmark. The main organisations involved, in addition to the university, are the NDR, the Aalborg municipality, and ICT Norcom. Aalborg university has in general a very comprehensive third mission activity ranging from Exploratorium for younger students

via incubators and consulting services to commercialisation. One particular important institution with respect to entrepreneurial discovery is 'matchmaking', a type of technology broker activity or infrastructure, which aims at increasing university-industry cooperation by assisting firms, typically SMEs, which only have a limited knowledge of the university, and which lack the absorptive capacity, to establish contacts with relevant researchers and research milieus. One additional important agency with respect to involving the broad population of firms in the region is the 'Growth house', which is located in the NOVI science park close to Aalborg University and has representatives in all the municipalities in NDR. It can offer assistance to individual firms with assessing their business potential, e.g. with respect to export, and how to exploit this potential. This represents a bottom-up type of potential entrepreneurial discovery.

This means that the leadership roles in NDR are in correspondence with the type of collaborative leadership that are recommended in the RIS3 Guide in the sense that strategic leadership is provided by the Growth Forum, while operational and commercial leadership is devolved to firms, firms-led associations such as clusters and network as well as to the university.

5b) Is the strategy evidence-based? How have areas of strength and future activity been identified?

The way the NDR and its Growth Forum work when designing their Regional innovation and development strategy, anticipating the actual RIS3 strategy document, is clearly evidence-based. As was shown in the previous section 4, the regional priorities are closely following the national priorities, which are both logically, as the NDR has its strength in many of the sectors prioritised nationally, and smart, as the big national funding schemes for research, innovation and development are to be found in relation to these sectors and areas. The prioritised areas are either traditional strongholds with future prospects of path renewal, i.e. diversification based on related variety or regional branching, or areas of great national and global societal importance where Denmark has the potential of obtaining competitive advantage.

In addition the NDR has a well-developed in house analytical capacity, which feeds the decision makers with up to date analyses of economic and social development trends. NDR has also made an extensive use of independent consultancy firms in evaluating the results of previous policies, which also includes recommendations for the future. These evaluations include analyses of cluster and network initiatives. The Growth Forum has also made use of SWOT analysis, which was referred to in the previous section, and which constitutes an important evidence based background for the priorities in the regional innovation and development plan 'Growth and Balance'. Thus, it seems as the NDR takes monitoring and evaluation (M&E) seriously in securing evidence-based decisions on the future RIS3 strategy with a vision for NDR maintaining and expanding its position as an innovative region, based on the three 'Ts', talent, technology and tradition

(not tolerance as Florida (2002) suggests), reflecting competences in the region as well as demand from private markets and public sectors regionally, nationally and globally, and, thus, looks credible and realistic.

5c) Does the strategy set innovation and knowledge-based development priorities? How have the potential areas of future activity been identified? How does it support the upgrading of existing activities?

As mentioned in previous sections and paragraphs the regional innovation and development plan sets innovation and knowledge-based priorities. The strategy partly, through statistical analyses, identifies traditionally strong sectors in the economy such as ICT, food, construction, the maritime sector, and tourism, and partly points to new areas of growth based on research strongholds at especially Aalborg University, such as health and life-science and health, energy, transport and ICT as a basis for commercialisation and new firms formation as well as an upgrading of existing industries (especially by the implementation of ICT). These research intensive and technology oriented areas are identified as regional front technologies. These sectors or areas are furthermore organised in clusters, networks and groups, the latter with reference to emerging clusters and networks. Thus, these priorities, building on the vision of NDR as an innovative region based on talent, technology and tradition, gives a sufficiently specified background with respect to identifying existing and potential niches for smart specialisation and related upgrading of existing and potential future activities.

The upgrading of existing activities is promoted in the plan by what is called firm-oriented competence development, which contains focus on continued education, the promotion of entrepreneurship and new firm formation, and strategy and market, by promoting innovation and new business models in firms in the region which among other things can improve their position in the global market. Such support is channeled through the Growth house and via international partnerships and networks.

As the regional strategy partly takes its point of departure in the existing and future strengths of the region, and partly also is in alignment with the national strategy, the critical mass and/or potential in the prioritised should be secured. However, given the lack of precise action lines on the operational level (see next point), it is difficult to be certain if the necessary economic means to realise the strategy will be available on regional, national and EU-levels.

5d) Does the strategy identify appropriate actions? How good is the policy mix?

This is probably the point that is most problematic in the regional innovation and development plan as there is not much written about concrete action lines or plans of implementation of the various elements in the strategy or roadmaps in line with the objectives. The Growth Forum has primarily a strategic responsibility, while the implementation is left to key organisations, with which Growth Forum established a

cooperation agreement for strategic development of the region. In the period until 2014 Growth Forum has such agreements with Aalborg University, Growth House North Jutland, Visit North Jutland (the regional tourism development agency), the vocational schools, and the University College North Jutland (professional education). These organisations represent the operational level in the governance structure. The choice of partners to collaborate with is a reflection of the strategic priorities made by the Growth Forum. This is seen in the allocation of funding as these organisations receive around 55% of all the funding for large projects. Moreover, the allocation of funding does also reflect the prioritised sectors in clusters and networks as well as the regional front technologies made by the Growth Forum. 37% is allocated to clusters and networks, 11% to the front technologies and 46% to firm oriented competence building. Thus, the main responsibility for formulating concrete action lines lies outside the Growth Forum, and relies on the implementing capacity of the respective partners, which have a cooperation agreement with the Growth Forum. One critical element in this context is the ability to control if the use of funding by the partners is in correspondence with the strategic goals set by the Growth Forum

The more overall reasons for the lack of explicit action lines, especially at the operational level, are at least twofold: Partly it is an inbuilt weakness of the Danish system's close networked and democratically representative composition and partly Denmark is a country with a limited degree of devolvement compared to federal countries such as Spain and Germany, even if the regions are main responsible for important sectors such as health and welfare as well as for regional development, where the policies as such represent a sound policy mix.

In the democratic and representative Danish system, which is strongly consensus oriented, it will many times be difficult to make the necessary concrete strategic decisions that are required to make sure that the goals are achieved. Basically, strategic decisions means that some prioritised areas get more money and funding with the consequence that other areas get less, as there will never be enough money for satisfying all demands. In a representative and consensus oriented system such hard strategic decisions have a tendency to be avoided in favour of giving something to everyone and everything, which often leads to a funding that does not reach the critical mass to achieve the strategic goals.

The second point deals with the dependence on the national level for most of the funding relevant for realising the strategic plan, even if the region has control of a certain amount of money that can be used for innovation and regional development purposes (in the year to come around 100 million DKK). However, compared to e.g. the Basque country, which controls the regional tax incomes, and has a government that is responsible for allocating it, NDR has much less autonomy to make hard strategic decisions.

One solution to this problem might be to sign cooperation agreements concerning the responsibility for developing action lines and roadmaps as well as for the implementation of the strategic goals with other agencies outside the Growth Forum, which are more directly involved in innovation and industrial development. Such external agencies could be cluster organisations, which in such case would be consolidated by having their power strengthened as well as getting a more distinct role in the regional innovation system. The cluster organisations should reflect a triple helix constellation of stakeholders, where not least the university would have a key role to play, given its research and competence within the regional front technologies, which might be one of the strongest drivers of future cluster development. This is also mentioned in one of the evaluation reports.

Secondly, a clearer and more significant role should be given to the use of Public Procurement of Innovation (PPI), which is mentioned in the plan but not in a very 'committed' way, as an important and strategic driver of some of the sectors which represents front technologies. Especially within the health and welfare sectors this could be a strategy that could achieve majority in the Growth Forum and the Regional Council. During the coming years a large and new university hospital is being built in Aalborg close to the university, and as the public sector at the regional level is the critical and big customer, it has a large potential for promoting innovation and new firms formation within emerging areas, which is prioritised as future areas of competitive advantage. Here a close collaboration with Aalborg municipality would be recommendable and logical, as it also has PPI as one of its means of promoting innovation. A close collaboration with research strongholds within medical technology, i.e. the before mentioned Eir, and ICT would of course also be necessary in elaborating action lines to implement a PPI policy to strengthen highly prioritised areas in the regional innovation and development plan.

This would imply a division of labour between the Growth Forum and external organisations with respect to which aspects of the regional innovation and development plan the respective levels would be operationally responsible for. Using the RIS terminology the Growth Forum could be responsible for the innovation system broadly defined, i.e. which takes into consideration all organisations and agencies that might influence innovation, and which requires a close coordination between innovation policy, education policy, and labour market policy. The broad and representative composition of the Growth Forum is ideal to deal with this securing that the NDR becomes a learning region (Asheim, 2012). Then the operational responsibility for a regional innovation system narrowly defined, i.e. the systemic interaction between the subsystem of knowledge generation or exploration, mainly found at the university, and the subsystem of knowledge exploitation represented by firms in clusters and networks, could be delegated to triple helix based constellations of the most important stakeholders from university, industry and the public sector, still though with the overall strategic leadership located in the Growth Forum.

5e) Is the strategy outward looking and how does it promote critical mass/potential?

The regional innovation and development plan takes into account the competitive position of Denmark and the NDR with regard to other countries and regions in the EU but also beyond looking at potential important markets globally. The traditional dominating industries in the region such as the maritime sector, food (especially fish) and tourism operates on international markets. In the national and regional identification of sector and areas for future competitiveness thorough analyses have been conducted to map global growth areas, such as energy, water, and health and welfare technologies, where Denmark already has or has the potential of gaining future competitiveness. The strong research milieus at Aalborg University, especially within medical technology, energy and ICT, which in some areas are world leading, have a huge international network with respect to research and funding, e.g. as part of large EU Framework programs. Funding is also achieved from other international sources from e.g. Japan and the US. This extensive international network can also play an important role with respect to attracting foreign direct investment (FDI) to the region, especially R&D units of international firms, which partly find collaboration with the strong research milieus interesting and partly can exploit the highly qualified graduates coming from these areas.

As mentioned in a previous paragraph the plan also has a focus on promoting internationalisation of SMEs through firm oriented competence development, which as one of its focus points has strategy and market, mainly through the Growth House, which provides assistance to SMEs concerning their market opportunities also internationally.

NDR has a close collaboration with the other regions in Jutland or West Denmark, the Southern and the Central regions, which is focused on possible joint actions and cooperation in prioritised sectors and areas, as many of the prioritised sectors are the same in the three regions. Thus, collaboration about how each region should diversify their specialisation within sectors such as health and welfare technologies, energy, tourism, and food is established. In some sectors such delimitation is rather simple, such in the food sector, where NDR has its strength in fishery, while Central Denmark has its strength in dairy and meat production. Within energy a world competitive industry is dependent on a close collaboration between the research, competence and production milieus which are present in the three regions. In sectors looking at future competitiveness, such as in health and welfare technologies, collaboration is necessary to avoid unproductive rivalry which will only lead to none of the regions achieving international competitive advantage. This three-part collaboration is a very good example of the efforts done to avoid imitation, duplication, and fragmentation as well as to provide critical mass. In this context also the national level can play an important role in securing a sensible diversified specialisation among the regions as part of designing the SS strategy.

5f) Does the strategy produce synergies between different policies and funding sources? How does it align/leverage EU/national/regional policies to support upgrading in the identified areas of current and future potential strength?

As shown in previous sections the Danish system of R&I policies are very well coordinated also between the different domestic spatial levels. Thus, the regional innovation and development plan of NDR reflects the prioritised areas at the national level, and partnership agreements are signed between the government, building on the recommendations from the national growth teams (referred to earlier in the document), and the Growth Forum in NDR within the maritime sector as well as aquaculture. These agreements are annually revised.

A mapping and evaluation of the Danish innovation and industrial support system was carried out by a consultancy firm and published in January 2014 (Damvad 2014). In this report it is concluded that there are differences between the national and regional levels with respect to which policy measures are used. At the national level knowledge diffusion, cluster and innovation networks are the preferred means, while at the regional level more information, advising and consultations are the most preferred. This might indicate that the two levels complement each other, and, thus, contribute to the cohesion of the whole system.

Secondly, the evaluation shows that support from the regional growth forums and the growth houses have the highest preference when firms make use of more than one support form. Moreover, the evaluation shows a differentiation with respect to what type of activities for which firms apply for support. While support for research and development primarily is promoted through knowledge collaboration, clusters and networks, more market oriented aims such as entrepreneurship, marketing and export activities is primarily supported by consultations, typically given by the Growth houses. Finally, the evaluation shows that a few programs or support forms are specifically important for the cohesion in the system. Among these national policies specifically the innovation networks are of key importance. The innovation networks were established by the previous Council for Technology and Innovation (now merged into the Innovation Fund), and should stimulate cooperation between industry and knowledge generation (universities and R&D institutes) and diffusing (Technological Service institutes (GTS)) organisations. On the regional level the role of the Growth houses is important partly as bridge builders to regional policies and partly to national policies especially for SMEs in the regions.

As the NDR does not (yet) have a single RIS3 strategy document it is more difficult to say anything specific about synergies between national and regional programs and different European programs such as Horizon 2020. However, in my interviews with key regional stakeholders from private and public sectors a clear awareness of the opportunities that is offered by e.g. the Horizon 2020 research program was present, not the least by

researchers and third mission responsible persons at Aalborg University. Thus, there is every reason to believe that such potential synergies will be taken into consideration in the design of the SS strategy.

5g) Does the strategy set achievable goals, measure progress? How does it support a process of policy learning and adaptation? How is it to be communicated?

In the absence of a single RIS 3 strategy document it is more difficult to specify a specific set of goals or a single set of metrics against which progress can be measured (see also paragraph 5d). The strategy sets goals more of a vision or generic than specific type, e.g. that NDR shall become one of the leading innovative regions securing growth and development in the whole region. In the various cooperation agreements the goals are more specific, but still quite generic formulated. Thus, one can say that the goals are achievable on the one hand, but not that easy to measure if they are achieved on the other hand, due to their generic character.

The monitoring and evaluation system seems to be in place and working satisfactorily, often carried out by independent consultancy firms, but also through a register based performance measurement based on an analytical tool developed by the secretariats of the Growth Forums, the Danish Business Authority and Statistics Denmark. This tool is used both to monitor ongoing activity and to measure the effect or impact of completed projects. Due to the broad representation in decision making forums such as the Growth Forum and the Growth House, the basis for a continuous policy learning and adaptation should be in place, given that this activity is properly organised in e.g. living labs in a RIS3 strategy.

The broad and democratic representation in the important decision making forums also provide the best basis for an efficient communication of the RIS3 strategy to stakeholders and the general public, as all the stakeholders are represented in the Growth Forum, and all the municipalities (but not Growth Forum) are represented in the Growth House.

5h) What are the conclusions and which advice can be given to improve the strategy?

As pointed out above, the NDR does not yet have a RIS3 strategy document. However, its regional innovation and development plan, Growth and Balance, from the Growth Forum can surely be regarded as a regional research and innovation strategy, and, thus, provide a good basis for designing a SS strategy. In the following we shall point at what could be changed and improved in this plan for it to become a RIS3 strategy for the region. We shall primarily highlight substantial elements of the plan, i.e. the 'hard' aspects of how to upgrade and renew the industrial structure to sustain and increase competitiveness and secure regional resilience.

The industrial structure of the region represents in many ways a dual structure. On the one hand one finds the traditionally dominating industries, which are either large, process based firms as found within the production of cement, or firms, often SMEs, that depends on the experience based DUI mode of innovation. In a NDR context such firms can be found in the food, construction, maritime and tourism sectors. On the other hand there is the research and knowledge intensive, mostly emergent, sectors, which are based on commercialising research results from Aalborg Universities, and are described as 'regional front technologies' in the regional innovation and development plan.

The problems in the traditional industries with respect to making them more innovative and competitive are the weaknesses which are identified in the SWOT analysis of a low educational and competence level and a lack of investment in R&D. This implies that these firms and industries have a low absorptive capacity, which limit their capacity of accessing and acquiring new and often external knowledge, make use of new production equipment and penetrating new markets, especially international ones. It also handicaps them in approaching universities to make their knowledge more research based and/or informed, which would extend their mode of innovation to the STI type. What is needed is to build absorptive capacity of DUI based firms by increasing their research based competence (Isaksen and Nilsson, 2013). This is an important strategy for the upgrading of traditional industries, as research has demonstrated that combining DUI and STI makes firms perform better by utilising both analytical and synthetic knowledge bases. One example of this would be for the food industry to start producing functional food directed to the growing market of obesity in collaboration with biomedical research at Aalborg University and for the maritime sector to link up with the research on intelligent transport systems, logistics and ICT at the university, a collaboration which already has started. Functional food is, e.g. part of the upgrading of the food industry in Scania as part of a VINNOVA funded centre of expertise (Isaksen and Nilsson, 2013). The construction industry should also link up with the advanced energy research taken place at the university, especially with respect to energy efficiency, to produce sustainable buildings.

The other strategy of upgrading of traditional industries is to move into high value-added niches. This is a strategy that most efficiently can be realised by mobilising the symbolic knowledge base, often in combination with synthetic knowledge, and to apply a platform approach, i.e. transcending traditional sectors, in the concrete design and implementation. This would normally imply that the firms continue to rely on the DUI mode of innovation, but are able to climb the value-added ladder by introducing new products that has a high element of symbolic knowledge to achieve product differentiation and, thus, represent a unique product at the high-end of the global market. Recent studies, in this case from Italy, shows that regions with a significant symbolic knowledge base (but not prevalent) which is balanced with other knowledge bases, in particular with the symbolic, are the most positively performing.

In the regional innovation and development plan such possibilities of applying a platform approach based on combining knowledge bases, including symbolic knowledge, is among the proposals of the regional innovation and development plan with reference to the food, tourism, and experience based economy sectors. Here the potentials exist of combining food (gastronomy) with nature and culture to produce a tourist product that can be customised to the preferences of demanding international customers and create a high level of value added. Good Nordic examples of such upgrading strategies in tourism is the Ice Hotel in Northern Sweden with 30.000 guests every season (November-April) and The Santa Claus Village in Rovaniemi in Northern Finland which attracts visitors by advertising the possibility of crossing the 'magical' Arctic Circle in sledges drawn by reindeers. In addition, tourism could also be linked up to health research to expand the high-value added niche even more, and in the experience based economy ICT can be exploited as software input in the development of computer games. This thinking in platform approaches is quite innovative in a planning context, and is not present e.g. in the INNO+ catalogue's overview of strategic areas for investment in innovation. While the importance of symbolic knowledge can be found implicit in the NDR plan, this is a totally white space in the INNO+ overview. When innovative production is referred to, the focus is only on the sustainability dimension of textile products (and on implementing robot technology to increase productivity), while both the introduction of symbolic knowledge via fashion, branding and design as well as upgrading textile products to technical textile, combing synthetic and analytical knowledge, is missed out. It is not possible to achieve product differentiation only by focusing on sustainability; this has to be combined with a distinct branding and design, which then can be quite forceful on global markets. Denmark has a strong design tradition in fashion with names such as Georg Jensen, Royal Danish, Birger Christensen and Skagen just to mention a few, which can serve as a basis for further expansion within this high value-added niche.

An interesting example, especially with reference to the NDR, is the growth of fashion oriented textile production in the Spanish province of Galicia. Galicia is as NDR a region where fisheries are an important economic activity with the second largest fishing port in the world. In addition agriculture has always been an important sector and with respect to manufacturing industries food processing and ship building have traditionally been the dominating. Today the region also has a large automotive plant (Citroen in Vigo). However, most interesting in the region's economic development the last 40 years is the rise of a fashion oriented textile industry where the Inditex group, which owns brands such as Zara, Massimo Dutti, Bershka and several others, has been the major player. What is interesting with this case, is that Galicia does not seem to have a strong tradition in textiles and definitely not in fashion, such as is the case with Italian regions and their 'made in Italy' image. The reason for Inditex being in La Coruna is the quite common factor that the entrepreneur was born and raised in the region. The group is now the most profitable enterprise in Spain, the owner the richest man in Spain, and Zara the

largest fashion chain in Europe measured by number of shops. In addition, other fashion brands have been established in the region, such as e.g. Bimba and Lola in Vigo. This is not an example of regional branching but of new path development based on entrepreneurial search utilising the symbolic knowledge base as the basis for a diversified specialisation of the region's economy. Thus, it can be an example of potential new path development that can take place neither based on path creation building on new scientific knowledge nor on regional branching based on related variety. Perhaps this could be an inspiration for exploiting the fact that NDR is the largest producer of mink fur in Denmark, which is the world largest producer, for the production of fashion products from mink skin, which is now solely in the hand of Copenhagen firms (i.e. Saga Royal fur coats). In doing this the most exclusive global market should be targeted in a non-traditional way but still aiming for style, which according to Armani is different from fashion as such due to quality.

Similar as with fashion is the case for food, where Denmark has a strong reputation as an agricultural economy with a high quality food production, which has some of the most well-known brands in the world (e.g. Lurpak). In addition we have the growth of organic production where Denmark is world leading especially with respect to dairy products. The organic dairy producer, Thise, is very successfully exploiting this on the Chinese market for milk products, where it achieves very high prices for its products, which are perceived as safe and healthy. This is clearly based on facts, however, it could also be wider exploited by adding symbolic knowledge in the form of narratives, storytelling and packaging. The prevalence of many and high profiled Michelin restaurants in Copenhagen, such as NOMA using only Nordic ingredients, should also be used in marketing Danish food products internationally. If not this is a missed opportunity.

One example of the power of exploiting the symbolic knowledge base in the marketing of high quality food products, is the Swiss Balik salmon. This achieves 2-3 times higher prices than similar Norwegian smoked salmon, even if the basic raw material is the same, farmed Norwegian salmon. The difference is partly that Balik salmon is sold at Caviar House outlets at airports to achieve exclusivity and partly the story accompanying it, that it is made by a recipe from a Russian tsar and washed in water from a Swiss mountain river. Given Denmark's position as a big fishing nation with long traditions in value adding processing into high quality consumer product, this niche should also be exploited, especially by SMEs in NDR. Another example from the beverage sector is the vodka premium brand, Grey Goose, which manages to obtain the same sale price as Cognac XO even if the production cost is marginal in comparison. This is the result of an American entrepreneur exploiting the huge value added potential in bringing the price of vodka to the level of luxury cognac by using symbolic knowledge (branding and marketing). The paradox is that it is produced in Cognac but branded as a French product to exploit the association of France with luxury products and at the same time not to confuse it with the 'brown' spirit of Cognac. Moreover, it is interesting but not

uncommon to observe that an external actor was needed to discover the combination of a strong competence and a large idle capacity of distilleries in Cognac (as cognac can only be distilled for a period of six months) which could be exploited. After owning the firm for only six years, he sold it to the Bacardi group for 2.2 Bn US$. This is an excellent example of diversified specialisation based on related variety as well as of individual entrepreneurial discovery using symbolic knowledge as the key diversification resource.

Finally, the construction industry, which so far both in national and regional plans primarily have a sustainability focus, could also make use of the symbolic knowledge base linking up with design and architecture. This is especially relevant for rehabilitation of buildings, which is mentioned both nationally and regionally, where it seems logical to relate to the strong Danish architecture and design tradition which includes names such as Jørn Utzon, Henning Larsen, Børge Mogensen and Hans J. Wegner as well as a number of younger architects, who are becoming internationally known.

Both in national plans as well as in the regional innovation and development plan there are strategies for dealing with the problems connected to the low educational and competence level and the lack of R&D investments in many Danish firms, especially in SMEs in traditional industries. On the national level one finds mobility plans, i.e. subsidising the hiring of academic work force in firms not previously employing this category of workers as well as financial support for SMEs to acquire research based knowledge through collaboration with universities. At the regional level there is the focus on firm oriented competence development and continued education, the role of the Growth House as well as the matchmaking institution at Aalborg university. A stronger focus on the specific needs referred to above to upgrade the traditional industry to become more innovative, value-adding and competitive, especially by adding symbolic knowledge, should guide the design and implementation of the strategies of competence development in the RIS3 strategy. The fact that humanities at Aalborg university offer a master degree in Experience Design might be very instrumental in this context.

The other part of the dual industrial structure of the NDR is the research and knowledge intensive, mostly emergent, sectors, which are based on the regional front technologies within energy, health and life science, and transport (including logistics and the maritime sector). These areas all represent strong research milieus at Aalborg university. I would add ICT to these regional front technologies as it has been and still is both a research stronghold and an important industrial sector (although not as important as before) as well as a general purpose technology to increase productivity in other sectors. These technologies are found in firms which are part of regional clusters and network. In some of these areas, such as medical technology, energy efficiency and embedded software, wireless communication, and sustainable energy (especially connected to windmills), the research at the university are world leading.

Applying a STI or R&D based strategy is a very costly development and differentiating strategy, with a high failure rate and with a long term perspective of producing positive results with respect to new firm growth and job generation. This is why the previous mentioned study of Italian regions found that regions characterised by a prevalence of industries with an analytical knowledge base showed a poor performance. However, given the existence of the strong research base in key technologies which take on future societal challenges regionally, nationally and globally, this research capacity and access to the best knowledge internationally should of course be exploited in an optimal way. The traditional focus on a STI and R&D based strategy, manifested in strong science and technology policy at the national level in Denmark, represent an important asset in implementing such a strategy, especially as the regional front technologies are part of national prioritised technologies, too. If the available national funding for developing these technologies are mobilised together with accessible EU funding through Horizon 2020 and other relevant programs in a smart way, a considerable amount of funding should be available for the commercialisation of these technologies, leading to new firm formation, generation of high qualified jobs, and the attractions of FDI, especially R&D units from international corporations, which will take advantage of connecting up to leading research milieus at the university and the accessibility to a highly qualified labour force graduated from Aalborg university. In many ways, these resources are so far only marginally exploited in the region.

An example of such a R&D based strategy is Oslo Cancer cluster, established in 2006, which still is an emerging cluster with respect to exploitation and products on the market. This underlines the need for increasing the implementation capacity of STI based firms and clusters through strengthening their market and process competence, which often involves combining analytic knowledge of basic research with synthetic knowledge of applied research and development work as well as with symbolic knowledge (Isaksen and Nilsson, 2013). Oslo Cancer cluster is primarily a very R&D intensive cluster focusing on the long-lasting and costly commercialisation process from basic research to innovations. This case shows how a cluster organisation can be used to promote new path creation building on the commercialisation of new research results in this case based on the strong research competence found at the University of Oslo and the university hospitals in the Oslo region. Oslo Cancer cluster is part of the Norwegian Centre of Expertise (NCE) program for strengthening the most international competitive regional clusters in Norway, supported by Innovation Norway and the Research Council of Norway.

Another strategy for R&D based clusters, in NDR especially the ICT cluster, is to diversify by combining knowledge bases. A good example of such a strategy can be found in one of the 'Vanguard' regions, Scania, where the strong ICT cluster, originally established in 1983, has developed towards becoming a New Media and Digital Design, which was established in 2006 in Malmö. The ICT cluster was located in the IDEON science park in

Lund, where Ericsson developed software for mobile phones in close cooperation with Lund Technical University. The New Media cluster builds on combining the existing competences in mobile communication based on analytical and synthetic knowledge bases with new competences in media and design drawing on the symbolic knowledge base in collaboration with the local university college in Malmö. In this way the New Media cluster takes advantage of the new growth trajectory in the mobile phone industry, where the largest growth potential lies in design oriented software development (e.g. mobile phone apps). Small steps in the same direction are also taking place in NDR by combining competences in ICT and experience design.

This case illustrates using cluster development as a strategy for path renewal based on combining knowledge bases. The formation of the New Media cluster was facilitated by local and regional policy makers in Malmö Municipality and Region Skåne respectively.

One way to increase the development and exploitation rate of the front technologies is to make public procurement for innovation (PPI) a central instrument. Partly the whole area of health and welfare are confronted with huge societal challenges in general due to the aging of society, which requires these sectors to operate in a smarter way, and partly specifically the building of the new university hospital in the region close to the university, offers a big opportunity of using PPI to support the development of these technologies. In fact, all of the front technologies (energy, health and life science, and transport/logistics as well as ICT) could be stimulated by an effective use of PPI. As the public sector is the large, critical and demanding customer in this area, and the Region has the main responsibility for the health area, the Region has a unique possibility of influencing the development and exploitation of these front technologies. The Region and its Growth Forum should give this a high priority, and perhaps establish an agency with the operational responsibility of implementing such a policy.

To succeed with a R&D based development strategy, there will be a substantial need of talent, which is one of the elements of the regional vision. Thus, there will be an increased need of attracting more students to Aalborg university from abroad as well as to retain them in the region, which is dependent on the presence of enough high qualified jobs. In addition, one should contemplate the adding of a fourth ‘T’, for Tolerance, to the existing three (talent, technology and tradition) that constitute the vision for NDR as an innovative region. The SWOT showed that recruiting and retaining high qualified labour could be considered a threat to the future development of the region, which should give an incentive to focusing more on what Florida (2002) called ‘people climate’ in addition to ‘business climate’. The most important elements constituting a good ‘people climate’ are openness, diversity and tolerance. The relevant point in this connection is his argument that if cities were attractive for the creative class, due to a favourable people climate, job would follow people, and not vice versa, which is the normal situation, that people follows job.

Promoting the people climate would in the NDR context only be a relevant policy for the city of Aalborg, however, with respect to recruiting and retaining the creative class, Aalborg should be looked at as an asset for the whole of NDR. This problem can be illustrated by a comment from a representative from MAN Diesel in Frederikshavn, who said that it was not possible to attract highly qualified labour to Frederikshavn, and, thus, that R&D activities either had to be located in Aalborg or in Copenhagen. Thus, from a NDR perspective, attracting such people to Aalborg should be better than exporting highly qualified work places to Copenhagen.

However, to successfully promote new path development, either in the form of path renewal (regional branching based on related variety) or new path creation based on commercialisation of research based knowledge, will require concrete and specific action lines, which in section 5d) was referred to as probably the biggest weakness of the existing regional innovation and development plan. Here a governance reform was proposed, which implied a division of labour between the Growth Forum and external organisations with respect to which aspects of the regional innovation and development plan the respective levels would be operationally responsible for. Using the RIS terminology the Growth Forum could be responsible for the innovation system broadly defined, securing that the NDR becomes a learning region on the one hand (Asheim, 2012). The operational responsibility for a regional innovation system narrowly defined, i.e. the systemic interaction between the subsystem of knowledge generation or exploration, mainly found at the university, and the subsystem of knowledge exploitation represented by firms in clusters and networks, could on the other hand be decentralised to triple helix based constellations of the most important stakeholders from the university, industry, represented in strong regional clusters of firms based on the regional front technologies, and public sector representatives. Such consolidated clusters should have a clear mandate of promoting growth and jobs, still though with the overall strategic leadership located in the Growth Forum. This would provide responsible bodies, which are better equipped to make the necessary strategic decisions required to achieve a successful development of research and knowledge intensive, emergent sectors, as they would be more directly involved in innovation and industrial development. Adopting such a governance structure would imply that the region would come closer to using an innovation system approach for its innovation policy. Such a change in governance structures might make it easier to reach the necessary strategic decisions of how to allocate scarce human and financial resources in the best way to most efficiently promote the development, exploitation and diffusion of the regional front technologies to achieve new firm formation and job generation in the research and knowledge intensive sectors of strategic importance for securing the future innovativeness, competitiveness and welfare of the NDR.

NDR is a region with a rich resource endowment which has a position among European regions as an innovation leader. As Denmark it has good governance and strong

institutions. Denmark has a well-developed and coordinated national research and innovation policy with good connectivity between the national and regional levels. Thus, it has fulfilled the ex-ante conditionalities for designing and implanting a RIS3 strategy. At the regional level what seems to be lacking is a higher capacity of formulating specific and concrete action lines for developing a RIS3 strategy. This is a major challenge in the process of designing and implementing a productive RIS3 strategy for regional development in NDR.

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Appendix 1: List of interviews

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