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Towards Spatially Enabled e-Governance – A Case Study on SDI implementation*

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Abstract

Spatial Data Infrastructures have gained increasing awareness not only among researchers but also among executive level managers and politicians. Thus a well functioning spatial data infrastructure is seen as an important element in e-Government and online self-service systems. The adoption of the INSPIRE Directive has put spatial data infrastructure on the agendas of the parliaments around Europe and in many cases combined with national e-Government strategies. Although different approaches will prevail around Europe there is a need to assess the strategies in order to identify efficient solutions on common problems – often entitled best practices. The aim of the current paper has been to analyse the Danish approaches to SDI implementation, identifying innovative solutions as well as bottlenecks. Based on the research the paper ends up with some recommendations for SDI implementation in a collaborative environment.

Keywords: Spatial Data Infrastructure, INSPIRE, e-Government

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1 INTRODUCTION

Spatial Data Infrastructure (SDI) is a framework of policies, standards and technology that enable data providers to publish, and users to access and integrate, distributed heterogeneous geospatial information (Nebert, 2004). Designing, building, implementing, and maintaining an SDI draws on many different disciplines and requires examination of a large number of factors and issues. Organisational aspects are often overlooked in SDI assessments. SDI strategies are most often shaped by technical and economical aspects. During the preparation phase of the INSPIRE Directive many aspects of SDI were analysed and discussed by the INSPIRE Expert Group, but most attention was given to the technical aspects, although a so-called extended impact assessment (Joint Research Centre, 2003) discussed analysis of some of the legal and economic impacts of INSPIRE.

From a governmental point of view a spatial data infrastructure is seen as an important dimension in several e-Government initiatives and e-Government has been the key driver for all activities regarding information and communication technology in the public sector.

The Danish e-Government strategy for 2007-2010, entitled "Towards better digital services, increasing efficiency and stronger cooperation" (Danish Government, Local Government Denmark and Danish Regions, 2007) has three overarching strategic priority areas: a) better digital service; b) increased efficiency, c) stronger collaboration. The national SDI is one of the prerequisites for fulfilling the strategy and handling the new dependencies. By using a common geographic basis for administration, it is possible for example to link relevant data about the environment, traffic, health, property, companies and people.

A well organised SDI requires legal, institutional and technological frameworks facilitating the information flow between agents. Several case studies concerning SDI implementation have been carried out in UK (Pollard, 2003), the Netherlands (Bulens et al, 2007), and other countries. Also the so-called State-of-Play reports on the progress towards INSPIRE implementation in the EU Member States have been performed several times during the previous years (Vandenbroucke et al, 2009).

The aim of the current research project has been to analyse the Danish approach to SDI implementation, identifying innovative solutions as well as bottlenecks. The qualitative assessment is supported by a quantitative analysis of a detailed questionnaire to all public organisations carried out summer 2009.

After the introduction follow a description of the analytical framework based on the strategic challenges for SDI implementation and the dynamic understanding

of SDI development as conceptualised by Rajabifard et al (2002). Next, we analyse the Danish approach to SDI and e-Government based on the questionnaire carried out, and end up with a SWOT analysis of the strengths and weaknesses in the Danish SDI strategy with outlooks into the future on opportunities and threats. The paper ends with some conclusions and outlines for ongoing research activities regarding SDI.

2 ANALYTICAL FRAMEWORK

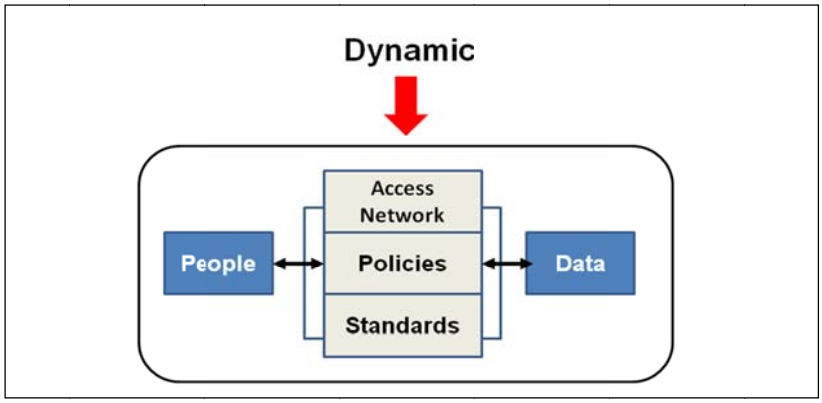
If public sector information is to be utilised to its full potential in decision-making and the creation of business solutions in today's society, then, there should be timely and easy access to the information for the user community. During recent years a number EU level frameworks have been established and several European countries have on their own made considerable efforts to facilitate the sharing and reuse of public sector information through SDI initiatives. Masser (2005) maintains that SDI development has often been dominated by central government bodies with little or without involvement from the local and regional levels. The development has been dominated by a small elite of GI professionals with in depth scientific understanding of spatial concepts, and the main challenge is how to develop an SDI serving the majority of the society who are not spatially aware (Masser et al, 2008). Masser et al (2008) have derived three strategic challenges. First, the implementation approach must be more *inclusive* – involving a large number of stakeholders from all levels of government, the private sector, and the research community. Second, enhanced emphasis must be put on *data sharing* between different kinds of organisations, and the benefits will emerge through the reduction of efforts in collecting and maintaining data. Third, *enabling platforms* must be developed to facilitate access to spatial information and related services. SDI as an enabling platform can be viewed as an infrastructure linking data users and providers through data sharing.

2.1 The SDI Framework

A Spatial Data Infrastructure is about facilitation and coordination of the exchange and sharing of spatial data. It is described as the underlying infrastructure, often in the form of policies, standards and access networks that allows data to be shared between people within organisations, states or countries. The fundamental interaction between people and data is governed by the technological components of SDI represented by the access network, policies and standards (Rajabifard et al, 2003). The diagram in figure 1 demonstrates the dynamic inter-relationships between the people and spatial data within an SDI. The dynamic nature of the spatial data infrastructure is attributed to the rate of technological advancement and changing user needs. People and data are the key elements in SDI, and a spatial data infrastructure at any level whether local, regional, national or even global involves an array of stakeholders both within

and across organisations including different levels of government, the private sector and a multitude of users. In order to design and implement a spatial data infrastructure, the stakeholders need to be identified together with the business processes and functions of the organisations involved. Besides you must know the data required or provided by the functions – and the flow of data between various functions. In this respect data sharing, exchange, security, accuracy and access as well as rights, restrictions and responsibilities must be managed.

Figure 1: Nature and Relations between SDI Components



Source: Rajabifard et al, 2003

Thus, it is evident that SDI's represent very complex systems and several researchers have utilised various theoretical foundations to understand the complex and dynamic nature of SDI. Onsrud and Pinto (1991) use diffusion of innovation theory to understand the spread and adoption of SDI, whereas Rajabifard et al (2000) developed a hierarchical concept which is very useful in describing the complex vertical and horizontal relationships between the political and administrative levels of SDI. Each layer of the organisational structure has distinct information requirements and therefore need support from a specific SDI level. Thus it is possible to classify different levels of an SDI hierarchy according to their roles played within different administrative levels. Grus et al (2010) takes outset in the theory of complex adaptive systems (CASs) which has been used in many disciplines from social sciences, organisational studies and biology to describe and better understand the features, mechanisms and rules of complex phenomena. They conclude that features and behaviours such as openness, level of self-organisation, adaptability and existence of feedback loop mechanisms, play an important role in the efficient and effective functioning of SDI.

2.2 The European Approach to SDI

Recognising the importance of a wider usage of public sector information (PSI) in the social and economic development of the European community the European Union has implemented a number of directives to support the sharing and reuse of PSI, and below we mention the three most important directives regarding INSPIRE implementation.

Directive 2003/4/EC (Commission of the European Communities, 2003a) on public access to environmental information was implemented in February 2005 as an EU implementation of the Aarhus Convention (UNECE, 1998), and although this Directive addresses specifically environmental information, it has nevertheless contributed significantly to the notion of easier access and sharing of public sector information.

The PSI Directive (Commission of the European Communities, 2003) was implemented in July 2005 aiming at regulating and stimulating the reuse of public sector information (PSI). The initial intention of the European Commission was to make all public sector information in the Member States available for re-use. However, this caused some Member States and public institutions great concern, as many of these institutions are expected to provide for at least part of their own funding. Therefore, in the negotiation process between the European Parliament and the Council, the general principle was toned down to a mere encouragement for the Member States to make their information available for re-use. Nevertheless, the PSI directive has gained lot of impacts in the Member States as demonstrated in the next sub paragraph.

A key objective of INSPIRE was to make more and better spatial information available for Community policy-making and implementation in a wide range of sectors. Initially, it would focus on information needed to monitor and improve the state of the environment - including air, water, soil, and natural landscape - and it can be extended later to other sectors such as agriculture and transport (Vanderhaegen and Muro, 2005). The INSPIRE Directive was adopted by the European Council and Parliament in spring 2007 and entered into force May 2007 (Commission of the European Communities, 2007). The INSPIRE Directive is a framework, where the details are defined through a set of so-called implementing rules, where the Member States provide experts for drafting the rules, which are finally adopted by the INSPIRE Committee. Thus a high degree of Member States involvement is ensured.

The European Geoportal (http://geoportal.jrc.it/) is considered one of the main building blocks of the European SDI (Bernard et al, 2005). The vision of the European Geoportal is to facilitate discovering, viewing, accessing, and querying geographic information from the local level to the global level, for a variety of

uses, such as environmental policy development and impact assessment, land use planning, natural disasters preparedness, monitoring, and response. Besides the European EU Geoportal serves as an information site regarding INSPIRE by providing links to newsletters, reports, and events.

Generally, the INSPIRE Directive is considered as a major step forward towards a pan-European spatial data infrastructure, but some concerns have been raised particularly regarding the organisational issues. De Vries (2009) maintains that INSPIRE is considered a Directive to harmonise what he calls geoICT in the public sector but hereby it aims indirectly and implicitly at new forms of cooperation between public authorities implicitly assuming that national contact points or authorities can steer INSPIRE implementation through non-problematic networking and effective cooperation between public authorities at all sub-national levels. This concern will be addressed later in the paper.

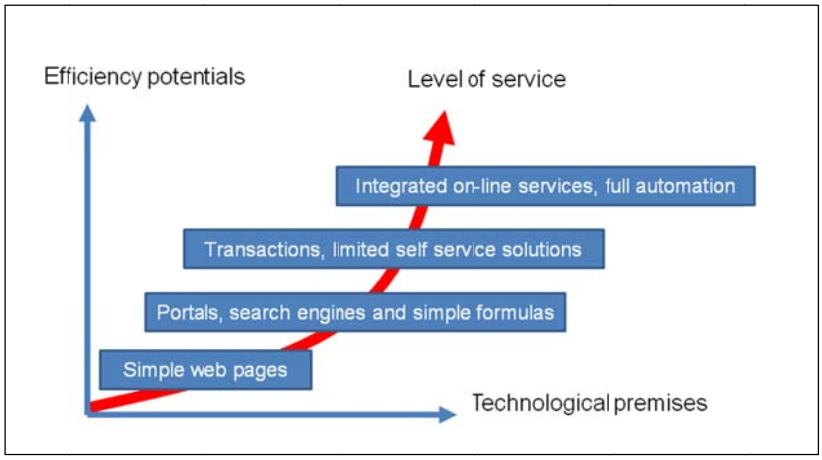
2.3 SDI Implementation in a National Danish Context

From a governmental point of view a spatial data infrastructure is seen as an important dimension in several e-Government initiatives. E-Government is generally being defined as the use of information and communication technologies (ICT) to improve the activities of public sector organisations and their agents (United Nations Department of Economic and Social Affairs, 2008) and e-Government has been the key driver for all activities regarding information and communication technology in the public sector. Since the mid-1990ties various Danish governments has put e-Government on the political agenda with initiatives like "Information Society by the year 2000" (Danish Government, 1994) and not at least “Project Digital Government” (Danish Government, 2001), which sat up a so-called Digital Task Force aiming at enhancing e-Government solutions across the public sector. To underline the importance of the Digital Task Force it was chaired by the Ministry of Finance. Figure 2 illustrates the Danish visions for digital government.

The Digital Task Force recognises the importance of geographic information by claiming that for many public authorities, geographic location used together with other registers or databases has proved a valuable tool in a number of administrative tasks. Recently, the Digital Task Force even stated that geographic information is a backbone in e-Government (Larsen, 2006). Regarding SDI, one outcome of Project e-Government was the *Spatial Data Service Community,* which was established in 2002 aiming at developing and formulating a vision and a strategic framework for the use of geodata in Denmark, ensuring co-operation on data production, data specifications etc., and promoting development of coherent geodata services. This top-down approach is illustrated in the upper part of figure 3. A basic and continually upgraded infrastructure is required to facilitate integrative opportunities for delivering services and engaging

citizens, whereas the exploitation of such opportunities demands engagement and participation among all stakeholders in order to foster more systemic transformation individually, organisationally and institutionally (Danish Government, Local Government Denmark and Danish Regions, 2007). The strategy was mainly developed by economists and jurists with limited knowledge about geographic information.

Figure 2: Development of e-Government

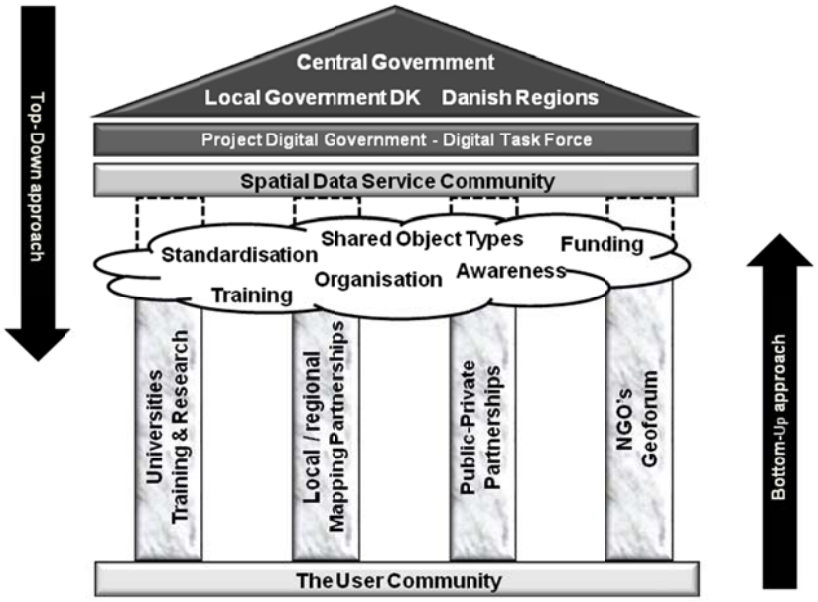


Source: Danish Government, 2003

Prior to the Danish e-Government initiatives the GI-sector has launched many activities, which are generally seen as important building bricks in a spatial data infrastructure. Since the Mid-1980ties a lot of efforts regarding standardisation of spatial information have taken place, and these efforts were enhanced by the launch of Open Geospatial Consortium in 1994 and the first Global Spatial Data Infrastructure Conference held in Bonn in 1996. The idea of a Danish SDI was thus launched by the research community (Brande-Lavridsen, 2002). The funding of digital mapping was made available through public-private partnerships, where the municipalities and the utility sector were the main contributors. During this period the Danish society moved steadily towards SDI by collecting data, making institutional arrangements and adopting standards – but without any overall strategy. Although these local initiatives had significant impact on the use of geographic information, the initiatives were uncoordinated, and in some cases even competing and contradicting. This bottom-up approach is shown in the lower part of figure 3. The people involved in this process was mainly GI specialists, consultants and researchers, which were very enthusiastic but with limited access to the decision making levels.

The INSPIRE process brought these groups together through the Spatial Data Service Community. INSPIRE implementation is a complicated process involving the government level to produce the national legal frameworks for the INSPIRE Directive. In addition the technical implementation is also very complicated, and needs GI and computer science specialists. Thus an obvious solution would be to combine the expert knowledge from the bottom-up approach with the executive power from the top-down approach – and that was actually done. The result is a high degree of consensus between decision-makers and users regarding the build up of a Danish SDI.

Figure 3: Building the Danish Spatial Data Infrastructure.



Cooperation is however a frequently researched topic in public administration science and empirical evidence shows that changing existing forms or introducing new forms of public sector cooperation has often proven to be problematic (Kumar and van Dissel, 1996). This is not necessarily because good intentions and agreements on objectives are not reached, but because public sector cooperation is often burdened with organisational and political motives, such as legitimacy, accountability, short term priorities and public image, which may counteract the cooperation structures and related technologies. Thus changing paradigms for governance with different epochs of centralisation de-centralisation and re-centralisation may complicate the development (de Vries, 2009). The same is true concerning outsourcing and privatisation.

3 RESULTS

During summer 2009 Aalborg University and Geoforum Denmark – the Danish national GI organisation – carried out a web based survey to study the readiness for INSPIRE implementation in Denmark. The questionnaire contained 63 questions and was sent to *all* public organisations – i.e. ministries, national agencies, universities, regional authorities, and local authorities (municipalities). The response rate was 81 % and among 98 Danish municipalities 75 have answered the questionnaire as well as 47 other public organisations at the regional and national level. 95.7% of the organisations use geographic information. The output of this survey gave valuable information in the analysis of the Danish capacity building concerning INSPIRE implementation, and the results are presented and discussed in the next paragraphs.

The most striking result of the survey is concerned with the challenges of using geographic information in the public sector. Fast and easy access to relevant information is considered as the most serious challenge for use of geographic information. Data quality and reliability is another challenge frequently mentioned. Both challenges underline the need for a well functioning spatial data infrastructure. Targeted and user friendly GIS tools is also a bottleneck for the use of geographic information. Contrary the costs of data and tools are a minor issue.

The analysis below takes outset in the various SDI components shown in figure 1 and the information used is partly obtained through studying the web sites of the key organisations mentioned above, and partly the data from the questionnaire.

Table 1: Challenges for the Use of Geographic Information

	Municipalities	Other public
Data costs	15%	21%
GIS Tools costs	23%	21%
Fast and easy access to relevant information	63%	45%
Data quality and reliability	40%	36%
GIS Tools usability (targeted and user friendly)	49%	32%
Other	7%	9%
Not answered	21%	25%

3.1 Policies

Masser et al (2008) notes that hierarchical governance structures are required to enable the participation of national and local governments and the private sector in decision making. However, hierarchical structures are typically operating top-down, with authority flowing from higher to lower levels. That is also the usual Danish way of implementing reforms and innovation in the public sector – from the national state level to regions and municipalities. Nevertheless, a combination of consensus-based decisions and mutually binding public-public and public-private partnerships has traditionally been the driver for the development of SDI in Denmark. Due to the INSPIRE Directive the approach to SDI has changed. The Danish Parliament transposed the INSPIRE Directive into Danish law in December 2008 by adopting a new law concerning the setup of an Infrastructure for Geographic Information. This law entered into force May 2009 and hereby stating that geographic information is now considered as a key component in e-Government. Besides the national policies the local SDI's need to define and agree upon their own data policies in order to ensure a common understanding on difficult issues like ownership, licensing, and Intellectual property Rights (Hansen et al, 2008).

3.1.1 INSPIRE Awareness

INSPIRE supports the ongoing development by implementing national standards for SDI, which of course will affect the local SDIs. The survey shows that approximately 75 percent of the public authorities are aware of the INSPIRE Directive, and more than half (nearly 60 percent) is familiar with the Danish Law concerning Infrastructure for Geographic Information.

Considering the sources of information about INSPIRE the responses illustrates that 68% of the municipalities obtain knowledge by the national GI organisation Geoforum, 24% are participating in special seminars on INSPIRE, 38% of the municipalities are consulting the Danish INSPIRE homepage, whereas only a few answers from the municipalities points out the official EU INSPIRE homepage as the main source to information. Only 11% of all answers mention the official INSPIRE homepage as the main source to information – and not surprisingly this group represents universities and governmental agencies. The share of organisations using Geoforum decreased to 55 % when regarding all respondents. Additionally, 25% of the organisations are member of the national INSPIRE network stimulating discussions regarding INSPIRE among Danish organisations.

According to the survey INSPIRE is discussed to a great extend at the technical level, as 37 % answers that only the technical staff is involved, 10 % are having discussions at the technical level as well as at the management level, while 15 %

experience it as a matter solely handled by the top level. Almost half (44 %) the answering organisations points out that they have a local GI Strategy, and 70 % are having a GI-coordinator, while only one organisation (a national agency) has made a specific strategy concerning the implementation of SDI.

3.1.2 Funding

Earlier the Danish funding model was a combined model that encompassed government funding and cost recovery, but from 2009 a new model was launched. All ministries pay an annual fee to KMS (the Danish national mapping agency), and in return, all the central government agencies and institutions will gain access to KMS' geodata and related services. A similar Municipal Geodata Agreement was reached with Local Government Denmark in 2009, and will come into effect in 2010 (Danish Ministry of the Environment, 2010). Hereby one of the major obstacles for fulfilling the INSPIRE principle, that *spatial data needed for good governance should be available on conditions that do not restrict their extensive use* is eliminated.

3.2 Standards

Technical standards are essential for the efficient sharing of products and to provide information about spatial data. Technical standards are designed to simplify access and improve data quality and integration. Standards groups include the Open GIS Consortium (OGC), International Organisation for Standardisation (ISO) Technical Committee 287. The Danish standardisation efforts go back to the 1980ties, where the national data exchange format DSFL was developed as a bottom-up process among researchers and consultants involved in digital mapping and facilities management. However during the late 1990ties the shortcomings of a national system became more and more obvious. The work in Open Geospatial Consortium, GSDI and not at least the INSPIRE process starting in 2001 stimulated the use of pan-European and even global solutions. Besides the e-Governments initiatives taken by various Danish central governments during the last decade have emphasised the importance of standardisation.

3.2.1 National Standardisation Efforts

The most recent e-Government strategy says that the most essential prerequisite for creating interconnectivity between IT systems with different functions supplied by different software providers is to ensure that IT systems are based on the same open standards (The Danish Government et al, 2007). The implementation strategy is a combination of facilitating the development by establishing supporting services and pushing the development in a chosen direction by setting goals and making recommendations. This work is supported by another

interrelated public project – The OIO-project – a more technical approach to the ongoing e-Government development. OIO is an acronym for Open Public Information Online. The OIO-project is to be seen as the toolbox for e-Government. It is through the OIO-project the choice of XML and SOA as the recommended concept has been made (Danish Government, 2003).

The future goal of the OIO project is easy management of information and easy accessibility of governmental information for the citizens, for business etc. The goal is also interoperability of information – nationally and internationally. This means the OIO metadata must be compatible with metadata which are in use by other governmental and local government agencies – or be using the same metadata standards. In principle, the OIO project consists of two main parts - developing a metadata standard which is compatible with other governmental metadata standards, and developing applications based on the metadata.

Parallel to this general standardisation effort several other initiatives have taken place. Thus in order to support interoperability of spatial information the Spatial Data Service Community in cooperation with Geoforum (the Danish GI Association) has launched several implementation guidelines like a WMS Cookbook, a WFS cookbook, and a National GML Profiles.

The standardisation initiatives have had an impact on the user community (table 2), and 90% of the organisations agree that standards are important – but difficult to implement (44%). However, more than half (55%) of the organisations maintain that the benefits of standards exceeds their implementation effort, and 40% found standards crucial for their organisation.

Table 2: Attitudes to standards in the public sector

	Agree	Neutral	Disagree	Do not know
Standards are important	91 (90.1%)	6 (5.9%)	0 (0%)	4 (4.0%)
Standards are difficult to implement	44 (43.6%)	36 (35.6%)	6 (5.9%)	15 (14.9%)
Benefits of standards exceeds the implementation efforts	55 (54.5%)	25 (24.8%)	12 (11.9%)	9 (8.9%)
Standards may be crucial for my organisation	40 (40.4%)	43 (43.4%)	7 (7.1%)	9 (9.1%)

3.2.2 Metadata

In 1994 the Danish National Survey and Cadastre published the first version of the so-called Info-database on Geodata (http://www.geodata-info.dk). The purpose of the Info-database was to create an electronic catalogue describing - in a uniform way digital maps and other collections of geodata from public and private data producers. At that time the system was quite innovative, and at the beginning there were high interest among Danish data providers to upload metadata information, but as time went on the economic resources to maintain the system was no longer available and the wider interest for the system declined. According to the survey 64% of the organisations use metadata – at least in some extent. However the metadata profile must at least fulfil the requirements as stated in the INSPIRE Implementing Rules for metadata (Joint Research Centre, 2010). National guidelines for doing this are provided and the practical implementation is straight forward. A much more difficult question turns up, when some organisation argue for more detailed metadata than required at the national and EU level. Generally, there must be vital reasons for the organisation to extend the metadata profile; otherwise it would be waste of resources.

3.3 Access

Accessibility to data, metadata, and user-friendly and efficient access and distribution systems represent fundamental building blocks in an SDI, and the importance of this is emphasised in the INSPIRE principles stating that *it should be easy to determine which spatial data are available, to evaluate their fitness for purpose and to know which conditions apply for their use.* Access to information has gained increasing attention since the mid 1990ties, where the emerging Internet was seen as a way of publishing information about information – i.e. metadata.

3.3.1 National Geoportals

A Geoportal can be defined as a web site acting as an entry point to sites with geographic information, and allows the users to search and browse between huge amounts of data sources (Tait, 2005). After the start of the new millennium the project e-Government initiated a new agenda for the work towards SDI and increasing accessibility to information was given high priority. Below, some of the most important facilities regarding access to geographic information are presented.

Danish National INSPIRE Geoportal

The Infodatabase on Geodata mentioned above is still in use, but do not at all satisfy the requirements today, but during the last 1 – 2 years a lot of efforts have

been carried out to make a new version based on the requirements according to the INSPIRE Directive, and the Danish Geodata law. When the portal is launched in summer 2010, the website will make it easier to find, add and edit metadata while providing information on the licence conditions and limitations that may affect access to the geodata themselves (Ministry of the Environment, 2009). The portal will not be limited to data providers responsible according to the INSPIRE requirements, but all data providers will be encouraged to take advantage of the portal as a central facility for metadata publication.

Open Public Information Server (OIS)

The Public Information Server – OIS (www.ois.dk) maintains detailed information about all properties and buildings in Denmark. The OIS was launched in 2001 and is administered by the Danish Enterprise and Construction Authority. Through a web based interface property owners have free online access to their own data, and database extracts in XML format are available through distributors. Addresses have long ago been seen as a very important reference data set for SDI, and the Public Information Server provides address data for free to the public as well as private sectors.

Map Supply

The Digital Map Supply (http://www.kortforsyningen.dk/) is a fundamental part of the Danish spatial data infrastructure and meeting several of the INSPIRE requirements for geodata distribution services. The Digital Map Supply distributes geodata as web services (WMS and WFS) based on a service-oriented architecture (SOA). The geodata available from the Digital Map Supply comprises digital topographic maps and cadastral maps.

Environmental Portal

A result of the administrative reform, the Danish Nature and Environment Portal (http://www.miljoeportal.dk/) was established. The portal is a result of a partnership between the Ministry of Environment, Local Government Denmark and the Danish Regions, and the aim is to ensure easy and free access to information about nature and the environment, and herby facilitating digital government. Data are available as web services (WMS and WFS) or as traditional downloads in form of shapefiles.

PlansystemDK

PlansystemDK is available from http://www.plansystemdk.dk/ and contains plans produced in accordance with the Danish Planning Act. The geoportal ensures that planning data are standardised and universally accessible. PlansystemDK provides easy access to municipal and state spatial plans and is a simple way for the municipalities to report their plan proposals and adopted plans to the national

public authorities. PlansystemDK was recognised as an outstanding approach to local SDI in Europe and awarded by the eSDI-Net+ project in 2009.

The systems provided are all adapted to the user communities and sufficient for their work. Referring to the PSI Directive, they are at the same time good examples on the re-use of public sector information. However, we still need to have one entrance to spatial information, and hopefully this will be provided by the new Metadataportal, which be public available during this summer (2010).

3.4 Data

A central component of a SDI is the data or spatial information itself, and so-called reference data are particularly important. The concept reference data is based on two main ideas: 1) It is a series of dataset that everyone involved with geographic information uses to reference his/her own data as part of their work; 2) It provides a common link between applications and thereby provides a mechanism for the sharing of knowledge and information amongst people (INSPIRE RDM Group, 2002). The RDM-group agreed that the following components will form the geographical reference data: geodetic reference data, units of administration, units of property rights (parcels, buildings), addresses, selected topographic themes (hydrography, transport, and terrain), geographical names, and to some extent ortho-photos. These data sets are nearly similar to the annex 1 data of the INSPIRE Directive, although annex 1 includes data on protected areas and geographical grid systems, but not ortho-photos (COM, 2007).

3.4.1 Reference Data in Denmark

The ETRS89 reference system was implemented nationwide in the public sector during 2006, and a national geographic grid based on ETRS89 and UTM zone 32 has been in operation since 2002 (Danish National Mapping Agency, 2002). Digital maps for all administrative units in different accuracy have been made freely available for all purposes – public or private (business) – and can be downloaded from the National mapping Agency under the acronym DAGI. The Danish addresses were focus for a project running from 1996 to 2004. The aim of the project was to improve and standardise addresses, which are one of the most important database keys in the public government. Besides each address was assigned a geographic reference (coordinates) facilitating its use together with digital maps (Lind, 2008). The cadastral map was digitised during the 1990ties and since 1999 all cadastral management has been carried out digitally (Enemark, 2002).

The topographic themes and geographic names are more complicated – mainly due to historical reasons. Because local mapping has historically been widely

dispersed and driven by independent needs, country-wide maps of Denmark have been difficult and expensive to maintain. Encouraged by the INSPIRE initiative activities have emerged at national and local levels. Thus a common agreement about the notion of data being born and maintained at the source has been established. Together with the Spatial Data Service Community and Local Government Denmark, the National Survey and Cadastre has launched FOT-Denmark to establish a national base map for use at all administrative levels by combining the nationwide topographical TOP10DK database, which has a specified accuracy of 1 meter in all three dimensions, and large-scale technical maps with an accuracy requirement of 10-20 cm used by local government administrations (Dael et al, 2008). Nearly all municipalities have joined FOT-Denmark, but although FOT is still in the implementation phase, about one third of the municipalities have already covered their territory with FOT maps. It is crucial that FOT geodata is established nationwide in the coming years to ensure that FOT becomes an integral part of the national spatial data infrastructure and, further, the e-Government (Jarmbæk, 2009).

3.4.2 Data Flows

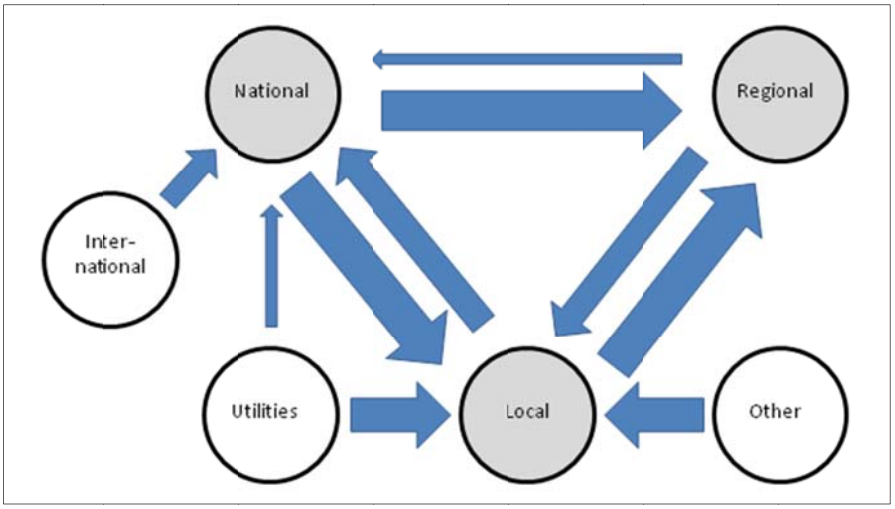
Traditionally most organisations provided data mainly for their own use and with limited exchange of data between organisations. The emergence of digital government and the aims of fulfilling the main SDI principles as stated in the INSPIRE Directive have changed this situation dramatically. Fast Internet connections together with geoportals have encouraged this development.

Facilitating the flow of data is as mentioned above a major role for SDI not at least as the Internet has become the predominant mean to distribute geographic information. 77.7% of the organisations offer geographic information services available to other organisations or the public through the Internet. Furthermore 72.8% of the organisations expect to extend the delivery of geographic information services through the Web to the citizens, and 64.1% to other public and private organisations.

Based on the survey an overall structure of the flows of data is obtained. Figure 4 illustrates the overall flow of geographic information between the public user communities. The national organisations are the main data providers primarily due to the National Mapping Agency (KMS), but also the Geological Survey and the various environmental agencies are important data providers. Most of the data hereby provided are available as WMS and WFS services through geoportals. The local authorities (municipalities) represent another big data provider. Through the daily local administration regarding, persons, buildings and the environment huge amount of data is produced and sent to the state for subsequent processing. Thus a significant part of the data received from the national organisations is originally collected by the municipalities. The regional

authorities have limited resort where health care and hospitals account for more than ninety percent of their budgets. Accordingly they play a minor role as data provider for the other user communities, and generally they receive most of their information from the national and local organisations.

Figure 4: The flow of Data between the Main Users of Geographic Information. The Width of the Arrows Indicates their Relative Importance for the Receiving Community.



3.5 People

Denmark is now ranked as number two in the UN E-Government Readiness Rankings (2008) giving good opportunities for SDI implementation geographically (country wide) as well as organisationally from national over regional to local levels. However, a well educated and trained workforce is an important prerequisite in building SDIs as well as full implementation of e-Government. This will require larger organisations with room for specialisations, and this was mentioned as one of the main backgrounds for our recent structural reform. The Danish structural reform in 2007 reduced the number of municipalities from 275 to 98 and the 14 counties were reduced to 5 regions, whose main task is to take care of the hospital sector (Ministry of Interior and Health, 2006).

People working with geographic information primarily use GI tools for information retrieval and simple analyses, but according to table 3 there is a need for more GI skilled people in most organisations. According to the survey 91.7% of the organisations maintain that they need to upgrade their GI qualifications within the next three years. Basically, this can be done in two different ways – by further education of existing staff or by hiring new persons with sufficient GI

qualifications. According to the answers in the Danish survey further education of the existing staff in order to meet the need for further competence is of great importance. 72 % will upgrade staff to be able to perform at a simple GI use level, 62 % will upgrade perform at an advanced GI use level, and 48 % will upgrade teaching, management, and support functions.

Table 3: Meeting the GI Qualifications Requirements

	Further training	Recruitment	Consultants	Other	No answer
Surveying & mapping	32%	4%	20%	2%	9%
Research & Devel.	21%	4%	18%	2%	13%
Management & support	48%	1%	8%	2%	7%
Simple use	72%	1%	0%	2%	3%
Advanced use	62%	5%	11%	2%	3%
Other	8%	5%	10%	2%	16%

4 DISCUSSION

The complexity of SDI with inter-related and interconnected technical and institutional elements and the multiplicity of stakeholders involved imply that governance is an important aspect of the institutional framework necessary to support decision making about all aspects of an SDI (Rajabifard et al, 2002). Above we have described the Danish approach to SDI implementation and analysed the capacity through a nationwide survey among all public organisations. In order to obtain a deeper insight in the sustainability of the Danish strategy a SWOT analysis was carried out in order to identify the strengths, weaknesses, opportunities and threats.

4.1 Strengths

The SDI is considered as a fundamental element in the Danish strategy towards digital government, and accordingly SDI is integrated in all e-Government

initiatives. The combined top-down / bottom-up approach as described in section 2.2 ensures a national coherent strategy with awareness and responsibility at the political and executive levels as well as support and involvement from the user community. An inclusive and participatory process like this is the best way of making the user community accountable, but it requires cooperation through well defined obligations and responsibilities. Therefore, cooperation is a key characteristic in the Danish SDI. This is confirmed by the questionnaire where 71% of the organisations have cooperation with external organisations through written and signed agreements.

4.2 Weaknesses

A fixed and well organised structure leaves limited room for experiments and perhaps put a damper on innovation regarding technology as well as organisation. In the longer term this may reduce competitiveness in a globalised world.

4.3 Opportunities

A well established and effective SDI as a fundamental element in digital government can contribute to increasing welfare through extended self-service by the citizens regarding more trivial interactions with the public sector like for example requesting simple building permissions. This situation refers to the upper right corner in fig. 2 on the Danish e-Government vision. This kind of self-service can save personal and economic resources for health care, education, research and other highly demanded public services. The free flow of data among public organisation can contribute to the development of innovative solutions through public-private partnerships and thus contributing to enhanced competitiveness of the Danish society. At the same time the society can take a step forward from the information society to the knowledge-based society, where ex-ante impact assessments through scenario methods will be a natural process before most decision-making (Hansen, 2010).

4.4 Threats

The economic crisis with severe budget reductions in most public organisations is the most critical threat for establishing a spatial data infrastructure and digital government. Especially the local governments are under economic pressure, and this may have negative consequences for the investments in technology and skilled people, which is absolutely needed for the implementation of local SDI's. However, an efficient public sector with extended use of online self-service is a fundamental requirement for the public sector to meet the challenges with for example an increasing share of elderly people, and fewer working people. This may end up in a negative spiral. Another threat is the general lack of people with

expert knowledge in information and communication technology as well as spatial information.

Overall the Danish capacity building to SDI implementation seems to have good possibilities for success. The strengths clearly surpass the weaknesses, and the opportunities for a significant SDI contribution to extensive digital government seem promising. The threats from the economic crisis are serious, but can be mitigated by targeted initiatives from the central government. However, a strategy with self-organisation, openness and feedback loop mechanisms like the Danish approach provide SDI with the capacity to adapt to changes (Grus et al, 2010). A high degree of adaptability guarantees that an SDI can continuously develop by adjusting its structure, behaviour and goals to changing external circumstances.

The development of e-Government and SDI in Denmark reflects the technological possibilities and are to a great extend a result of engagement and shared responsibility among the players. This way of working implies a short way from the technicians to the decision makers, and often ideas born on one level is quickly adapted on the other levels (Schroeder et al, 2010).

5 CONCLUSION

The overall conclusion of the survey is that geographical information is an important component of e-Government, and is seen as an integrated and inherent part of the public administration in Denmark.

The Danish strategy towards a spatial data infrastructure has traditionally been driven by researchers and other specialist groups. Thus a bottom-up approach to SDI was already under way when the INSPIRE process started in 2001. The national digital government strategy efforts worked at the top-level, and made the political and administrative preconditions for SDI – not as a stand-alone structure but as an inherent component of e-Government.

From the survey carried out during the summer 2009 we can conclude that there in general is a high degree of awareness regarding INSPIRE, and that people at various organisational levels are appreciating the value of an SDI. One important factor in order to obtain a successful implementation is dissemination of information, which in this Danish case is being carried out most successfully through NGO interest groups, and by continuing education of the workforce. However, we can conclude that the main interest for SDI and INSPIRE comes from groups of GI- and IT-technicians, whereas SDI still lacks focus from the top management level. Especially the Danish Law on Infrastructure for Geographic Information and the national e-Government strategy seem to improve this situation and move geographic information into a key position in e-Governance.

Considering the sustainability of the established SDI due to the strengths, weaknesses, opportunities and threats identified in the SWOT analysis the dangers of too static organisational structures seems to be met by the national capacity for on-going SDI development based on an innovative collaborate approach. Despite the actual problems related to lack of investments caused by the current financial crisis the SDI implementation process as central part of the Danish e-Government strategy for digital government is of growing interest due to the potentials of knowledge-based solutions and integrated online self-services as means of meeting the increasing demand for efficiency in the public sector.

However, referring back to the three challenges raised by Masser et al (2008), we can conclude that the Danish approach has demonstrated innovative answers. The combined bottom-up top-down approach is clearly *inclusive* by involving all stakeholders – government bodies, researchers and private companies – in a process of mutual confidence. The definition and adoption of common objects types for technical and topographic mapping is a first approach to reduce the cost of data production through *data sharing*. The adoption of free use of all public sector spatial information among public bodies is another innovative answer to the data sharing challenge. The last challenge on *enabling platforms* is perhaps the most difficult answer, but not at least the Plansystem.dk and Miljoeportalen.dk are examples of SDI's with close linkages between the data providers and data users, and with common understanding of the underlying data models developed through mutual understanding between stakeholders at various levels. The links between users and providers are even so blurred that the users update information through the Geoportal in a Web 2.0 like model.

Sweden and Finland have carried out similar surveys with the same questions, and currently we have made a Nordic group to analyse the data in order to make comparisons, and develop guides for SDI implementation. Furthermore our on-going research will elaborate on the organisational challenges of flexible SDI development as part of ongoing improvement of spatially enabled governance concepts.

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