Interdisciplinary research project: SPATIALIST; Spatial Data Infrastructures and Public Sector Innovation in Flanders (Belgium)

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Abstract

In September 2007, Katholieke Universiteit Leuven and Vrije Universiteit Brussel started a four-year research project entitled *"SPATIALIST; Spatial Data Infrastructures and Public Sector Innovation"* funded by Institute for the Promotion of Innovation by Science and Technology in Flanders. The strategic and generic character of this project is situated in its research object as well as its method. The research object of the project is the relation between Spatial Data Infrastructures (SDI) and Public Sector Innovation in the Flemish Region. A lot of information in the public sector has a geographic component, so the large-scale roll-out of an SDI will be of great strategic importance in itself and to the further development and innovation of public practices. The method of the project supports a generic approach of SDI-development. First, the project looks at SDI-development from an interdisciplinary perspective. A discipline combination of public administration, sociology, law, economics and geomatics has to guarantee a comprehensive view on the development of an SDI. Second, the development of an SDI is looked upon in all its phases. The central research question to be answered in this project is the following: "what are the technological, legal, economic, sociological and public administrative requirements to further develop an operational Flemish Spatial Data Infrastructure consistent with international standards that is efficient, effective, flexible and feasible?". The aim of this paper is to present this unique strategic research project in terms of motivation, problem statement, state-of-the-art, strategic research question, analytical research model, research strategy, and valorisation potential.

Keywords: Spatial Data Infrastructures, Public Sector Innovation, SDI-development, Interdisciplinary

1. INTRODUCTION

In September 2007, several research groups of Katholieke Universiteit Leuven and Vrije Universiteit Brussel (Belgium) started a four year interdisciplinary research project entitled *"SPATIALIST; Spatial Data Infrastructures and Public Sector Innovation"* funded by Institute for the Promotion of Innovation by Science and Technology in Flanders.

In order to improve accessibility, interoperability and affordability of spatial data and information, the focus of the GI-community is now increasingly shifting to the challenges associated with integrating individual Geographical Information Systems (GIS) into a space and time independent continuum to support (1) public authorities and administrations at various levels, (2) thematic user communities, (3) enterprises and (4) citizen-oriented society as a whole (Williamson et al, 2003). A "Spatial Data Infrastructure (SDI)" is the envisioned outcome of such endeavour. An SDI addresses both technical and non-technical issues, ranging from the creation and maintenance of GI for a wide range of themes, technical standards and protocols, and organisational issues, to data policy issues including data access policy.

In the information society, information infrastructures are becoming the backbone of the public sector. Public administration and public policy will not be based on hierarchy, but on databases and information networks. In this way, the development of an SDI is expected to lead to profound public sector innovation. Classic hierarchical administrative structures will make way for networks of information. These networks of information will process and exchange information on citizens, organizations and geographic related elements. The increasing importance of networks of information will change the identity and role of the public sector, its relations with other actors in society and its internal processes. In the information society, the public sector will have to play new roles (e.g. collection of information in authentic sources of information). The public sector will develop new relations: instead of classic hierarchical relations, the public sector will operate in horizontal networks of partnership and collaboration. Tasks will be reallocated between the public, not-for-profit and private sector. This new identity, roles and relations will affect the internal processes of the public sector and its interfaces with other actors in society. Classic bureaucratic processes will have to be innovated and redesigned in order to be effective and accountable.

Being aware of all these changes, this project focuses on the identification of key requirements needed to develop an operational SDI for Flanders. The aim of this paper is to present this unique strategic research project in terms of motivation, problem statement, state-of-the-art, strategic research question, analytical research model, research strategy, and valorisation potential.

2. MOTIVATION

The developmental road towards a true mature SDI, keeping pace with societal and technical developments, is still long, and barriers and obstacles are incrementally becoming apparent. The appearance of a diffuse set of difficulties is increasingly acknowledged by many individual (groups of) practitioners in the field, and barriers for implementation have been regularly studied and commented on by rather individualised academics, all working from their own respective disciplines.

While the awareness of barriers regarding development and functioning of SDI is increasing, this is not to say that occurring barriers and obstacles are generally well-understood or well-defined, let alone well-addressed by practitioners as well as academics. While a Spatial Data Infrastructure is by definition the product of cross-cutting integration, problems that arise in its development are dealt with -with varying success- by individualised and fragmented categories of stakeholders. Conversely, while an SDI depends on the adoption of a unique ambition across a large number of diffuse actors, these actors often tend to act solely according to their own particular background and expertise. The basic axiom, therefore, on which this research project is based, is that problems arise because existing divisions between stakeholders in the development process are regularly dysfunctional to the attainment of the envisioned SDI.

The SDI itself, however, is nevertheless more or less a shared ambition across all stakeholders. This common ambition functions as an intrinsic incentive for stakeholders to continue or increase their participation in the development process. This unifying objective can thus be perceived as a strong source of cohesion, and this, in turn, is ultimately what may render the attainment of an SDI a feasible and valuable objective to pursue. The basic ambition of this project is to cut across the existing divisions between categories and groups of stakeholders in the field - whether these divisions reveal their selves in the form of professional groups, organisations, organisational departments, hierarchical layers or other - with the purpose to augment the readiness and capacity for SDI-development. Herewith there will be a strong emphasis on the technical as well as the organisational dimension of an SDI.

The societal importance of this endeavour extends far beyond the SDI in the narrow sense, since SDI as a policy-tool carries the potential to significantly enhance performance in monitoring and managing development of contemporary society in an open and transparent manner. There's a rather large consensus concerning the timeliness for setting up such an SDI. In relation to socio-

economic development, the issue of territory has received renewed attention from diverse disciplines in recent years (Molina-Morales et al., 2002). Somewhat paradoxically, although globalisation is generally perceived as a boundary-breaching process, policy attention is simultaneously shifting to the structural factors that determine the economic competitiveness of sub-national locations (Brenner, 2000). Arguably, while some general economic policy domains, for instance, have shifted up to the level of the European Union, other economic policy-levers are revised in order to optimise the targeting of policy-measures to particular socio-economic traits of disaggregated geographic units. Therefore, data that are required to inform and evaluate the policy-making process should increasingly include a geographic dimension. A great deal of policy issues are, moreover, by their very nature connected to territorial units (e.g. crime, urban development, spatial planning, traffic, etc.).

Gaining widespread consensus on the need for an operational SDI in the policy process is, however, not tremendously challenging when compared to the challenge of overcoming the difficulties that may be encountered in constructing, developing and maintaining an SDI. These problems are rooted in the need to rapidly adjust many different practices and procedures at the same time, e.g. hardware, software, regulatory arrangements and 'orgware'. These heterogeneous components of an SDI are mutually unrelated in the beginning, but have to become realigned in a direct and strictly defined relationship to one another in the course of the implementation project. Since the construction of an SDI requires simultaneous changes in many different domains and settings, the qualification of a 'radical innovation' applies (Nooteboom, 2001). Radical innovations often require boundary-crossing partnerships (Subroto et al, 2004), the transfer of distant practices (Delbridge, 2003) and even a shift towards mental models that are fit for this change (Pouder and St. John, 1996). The dramatic ring to the term 'radical' serves well to draw attention to the far-reaching modifications and changes that are necessary for an operational SDI to come into being. Following from this is the hardly surprising observation that, as innovations become more and more radical, the costs of failure are also becoming greater (Hage, 2001). Meanwhile, scarce but valuable evidence from empirical studies nonetheless presents a mixed record on whether GIS and SDIs are delivering on its promises (Birks et al, 2003; Crompvoets et al., 2004; Hall, 2004; Kok and Van Loenen, 2004; Nedovic-Budic, 1999; Nedovic-Budic and Pinto, 2001; Nedovic-Budic et al, 2004)

The development of an SDI, moreover, must be largely undertaken in the context of a public administration system. This is because spatial data are typically quasi-public goods, are associated with economic externalities and lead to natural monopolies (Martinez-Asenjo and Frank, 2002). An integrated Spatial Data Infrastructure is furthermore liable to the economic arguments of joint consumption as well as of joint supply, which essentially means that an SDI

should be intrinsically perceived as being a public good (Marmolo, 1999). This implies that the risk of free-riding behaviour is such that the establishment of an SDI cannot be efficiently brought about by the private market, but needs to be addressed in the context of public provision.

A more pragmatic motivation for the research project is the need for the Belgian and Flemish government to implement the European INSPIRE-directive in federal viz. regional legislation with emphasis on the non-technical components of the SDI and going beyond environmental policy matters focused by INSPIRE. In order to propose an adequate legal formulation and a thorough implementation plan, alternatives will be compared in terms of economic, social and environmental costs and benefits. In order to address the requirement set by the INSPIRE-directive for Member States (and regions within MS) to monitor the performance of the SDI, a multi-indicator-based approach will be formulated and used which might allow to ex-ante evaluate proposed implementation changes in terms of performance, monetary costs and benefits, user and citizen satisfaction, correctness of SDI-based decisions, division of labour, industrial relations, economic innovation, administrative efficiency and legal consistency, ...

The project emerged from a need experienced by different stakeholders of the Flemish SDI. The Association of Flemish Cities and Municipalities, the City of Leuven, the Association of the Flemish Provinces, OC-GIS Flanders, IncGEO and the National Geographic Institute already experienced the operational as well as strategic problems associated with the development of the SDI. The research questions of the project emanated from these experiences, and the outputs and deliverables of the project aim to be of utility to these stakeholders in the further development of the SDI. To monitor the utility of the project results, the stakeholders mentioned above are committed to participate in user groups.

3. PROBLEM STATEMENT

Although the interest in the impact of SDI-implementation is gradually increasing, evaluation studies are still rather scarce, and, more importantly, primarily focused on the technical issues of GISs as such, while the institutional framework, the policy, and human resources which are required to further develop and integrate multiple GISs into an SDI, are often described as stable, non-moving factors (Crompvoets et al, 2007; Grus et al, 2007; Kok and Van Loenen, 2004). Yet, the mere availability of technology is not a sufficient condition for an SDI to be used (Masser, 1998). While practitioners currently feel that it is precisely due to these non-technological issues that implementation of information systems often fails, in system development, technical issues still tend to override all other aspects, including human and social dimensions (Brooke, 2000).

To date, the structural, organisational and public management issues in GIS-implementation have only been addressed in a limited number of studies. Nedovic-Budic (1999) made up an overview of several GIS evaluation studies. The overview at the time revealed that the largest part of these studies assess efficiency and effectiveness solely in relation to the ultimate outcome of the GIS and neglect the effectiveness that is directly related to the organisational implementation of GIS itself, e.g. (Clapp et al, 1989; Antenucci et al, 1991). Nedovic-Budic infers that the organisational perspective within the public management context is necessary to improve the eventual performance of geographic information systems and argues that "the vagueness of organizational goals" prevents effective development and use of information systems" (Nedovic-Budic, 1999). Furthermore, most implementation evaluation studies adopt a rather narrowly defined set of performance criteria. Adman & Warren (2000), for instance, conducted a single-site case study on the implementation of an information system, and fully relied on the practitioners under investigation to identify efficiency and effectiveness-criteria. While this approach may be feasible for those delineated situations where organisational goals are well-delineated, stable in time and agreed upon by the large majority of relevant organisational stakeholders, this approach is infeasible for the evaluation of an SDI development trajectory that has a rather open-ended character.

When organisational and public management features are, however, explicitly addressed in studies that set out to evaluate a GIS-implementation process, these studies tend to lack an elaborated research frame that enables to analyse institutional and organisational barriers to the implementation of GIS, let alone SDI. A striking example of this shortcoming is a (recently) published article in the International Journal of Information Management that describes a 'fictional' case in which Nancy Hays, a local County Administrator, wants to integrate GIS into multiple county operations. After describing the acquired information from the relevant stakeholders in the County, several recommendations are expressed in the very final sentences of the article:

> "Nancy developed a list of the methods she could employ to implement GIS. She realized that actual implementation could incorporate several of these techniques as follows:
>
> - appoint a GIS coordinator within the County,
> - hire a GIS consulting firm,
> - allow each interested area to develop their own applications,
> - develop a vision for enterprise implementation.
>
> Nancy now felt she had enough information to develop a GIS implementation plan to present to the County Board." (Hall, 2004)

It is more than doubtful whether such a meagre scope of analysis would truly help practitioners in the field to foresee or overcome the obstacles that occur in the course of an SDI implementation. A better example can be found in a study on SDI-implementation (Nedovic-Budic and Pinto, 2001) that included, for example, some observations on the impact of data distribution policies, but lacks an analysis on how these policies can be developed and how these policies can be optimally aligned in accordance with intermediating organisational features. Similarly, authors, e.g. (Rajabifard et al, 2003, Crompvoets et al, 2004; Nedovic-Budic et al, 2004), have adequately pointed to the need for more pro-active behaviour and improved communication patterns from actors involved in the development and implementation of an SDI, but subsequently avoid the challenge of demonstrating how strategies to obtain the necessary pro-active behaviour from this divided and heterogeneous group of actors can be stimulated and organised. In yet another and differently conceived study on SDI, Kok and Van Loenen (2004), by contrast devote extensive attention to organisational methods and strategies to stimulate pro-active and collaborative behaviour in building an SDI in a public administration setting. Unfortunately, these authors rather one-sidedly address how organisations can stimulate their members to actively engage in identifying and solving problems, without actually clarifying the nature of potential problems and without bringing an effort to bear to stipulate tangible strategies or methods to actually solve or avoid these. The proposed key concepts –vision, leadership, communication and self-organising ability- seem to bring little concrete added-value in view of concrete problems or actual solutions. Comparing the Dutch with the US NSDI along these dimensions does in the end not lead any further than the symptomatically vague conclusion that “it is likely that both countries need different strategies for the further development of their NSDI” (Kok and Van Loenen, 2004).

Instead, what is needed in the GIS-context is “careful project implementation based on a full understanding of what must be done to avoid failure, as many GIS have never accomplished the claimed benefits made when the system was acquired” (Birks et al, 2003). Consequently, Birks et al. set out a research on GIS in the context of a private company in the UK retail sector and aim at analysing the significance of the triple organisational and individual qualities ‘ability’, ‘effort’ and ‘support’. These triple concepts are elaborated into a more sophisticated framework that eventually allows to demonstrate “the need to concentrate on individual’s task-related abilities, individual work efforts, and a mixture of organisational support. Take one or more away, and performance will surely be compromised” (Birks et al, 2003). This is surely rightly stated, and these issues undoubtedly deserve the attention that has been awarded to them in the study of Birks et al. While extending these general findings to other settings is self-evidently feasible, their analysis is however far from complete for our purposes. Many key concepts and mechanisms of integration of individual GIS into an SDI

are not addressed. The level of detail regarding, for instance, work organisation issues must be augmented; inter-organisational issues must be brought in, as well as the specifications of SDI-implementation in the setting of a public administration and the regulatory problems and legal frameworks that can inhibit successful SDI implementation. In this respect, the step from studying an individual GIS-implementation project in the context of a commercial retail company, to the development of an SDI involving a multitude of hierarchical layers and organisational entities in the context of public administration, produces considerable additional analytical complexity.

Fortunately, a move away from the commonly isolated and scattered approaches to production, management, dissemination and use of geographic information is currently strongly advocated by many stakeholders in the field, and is also increasingly acknowledged by the academic research community (e.g. the Dutch initiative “Space for Geo-Information”). An SDI is meant to help avoid fragmentation, gaps in the availability of GI, duplication of data collection and problems of identifying, accessing or using the available data. It is, however, important to note that this fragmentation and these gaps in the availability of GI may have a combination of technical, structural-organisational, social, and even legal roots. Because of the often complex and intangible origins of failures in data production, processing or exchange, it will not be self-evident in these cases to swiftly find effective solutions for the many different and often interconnected problems that may arise. It is indeed for this reason that radical innovation and development processes are also associated with radical uncertainty with regard to the roles and the expectations of others (Storper and Salais, 1997). Conversely, dismantling these uncertainties in favour of building up stable foundations for an SDI development is best explicitly and thoroughly addressed, rather than adopting a ‘clean slate approach’, as is commonly associated with Business Process Reengineering (BPR) which simply tends to ignore the pre-existing structural-organisational situation (Den Hengst and De Vreede, 2004). Recently, many researchers from diverse academic disciplines have, by contrast, based their empirical studies on the well-documented and logically straightforward, observation that the existent institutions constrain the range of options from which actors can choose when engaging in institutional innovation (Campbell, 2004).

4. STATE-OF-THE-ART

Rajabifard et al (2003) see an SDI as an initiative which is defined in many different ways, however its common intent is to create an environment in which all stakeholders can cooperate with each other and interact with technology to better achieve their objectives at different political/administrative levels. So, an SDI has a multi-level character: it is not one single system, but a range of interconnected systems from private and public organisations (at different levels

of government). Rajabifard et al (2003) describe this multi-level system of interconnected SDIs as an SDI-hierarchy. This hierarchy is mainly made up of SDIs at several government levels: a local SDI at the lowest level (e.g. a municipality or province), a state SDI (e.g. the Flemish level), a national SDI (e.g. the Belgian federal level), the regional SDI (e.g. the European Union) and the global SDI. At each of these levels, several initiatives have already been undertaken. The challenge, however, is the integration of all these initiatives. Integration has to happen between different SDIs of the same level in the SDI-hierarchy (e.g. between different municipalities) as well as between different SDIs of different levels of the SDI-hierarchy (e.g. between municipalities and the Flemish government).

Recently the Directive 2007/2/EC of the European Parliament and of the Council establishing an INfrastructure for SPatial InfoRmation in the European Community (INSPIRE) was published in the official Journal. With the INSPIRE initiative, the European Commission intends to trigger the creation of a European Spatial Data Infrastructure that will allow the public sector users at the European, national, regional and local levels, users in private, research and NGO-environments and the citizen, to discover, access and acquire spatial data from a wide range of sources in an interoperable way for a variety of uses at conditions which do not restrain its use. The EC and the INSPIRE expert groups firmly recognized that the building blocks for such an ESDI consist of the operational or emerging national, regional and local SDI (Masser, 2007). Within the INSPIRE framework five principles have been defined for an SDI in general and the ESDI in particular:

1. Spatial data should be collected only once and maintained at the level where this can be done most appropriately;
2. It must be possible to combine seamlessly spatial data from different sources across the study area and share it between different users and applications;
3. It must be possible for spatial datasets collected at one level of government to be shared between all different levels of government;
4. Spatial data needed for good governance should be available on conditions that are not restricting its extensive use;
5. It should be easy to discover which spatial data is available, to evaluate its fitness for purpose and to know which conditions apply for its use.

These principles result from the work of five thematic expert groups from EU25, which have delivered the so-called INSPIRE position papers in October 2002. The themes those expert groups dealt with were:

- Reference data and metadata;
- Data policy and legal issues;

- Implementing structures and funding;
- Architecture and standards;
- Needs of users of environmental thematic data.

The proposed ESDI has been the subject of an extended impact analysis by the EC which confirmed the large socio-economic benefits which will go along with the implementation of the infrastructure at European level (Commission of the European Communities, 2004).

At the Belgian federal level, the National Geographic Institute (NGI) has the ambition to act as a focal point for a Belgian nation-wide SDI. The NGI participates in the Federal Platform for Geo-Information. The Belgian Cadastre and the National Institute for Statistics also play an important role as supplier of geographic data. Yet, Belgium contributes to the E-SDI in the first place through its three regional SDIs (RSDIs).

In Flanders the role of developing and maintaining a regional SDI (RSDI), is taken by the partnership GIS-Vlaanderen. The partnership essentially consists of a coordinated network of regional, provincial, municipal administrations and other public bodies (the GIS-Vlaanderen-partners) aiming at sharing GI to fulfil their public mandates. The regional agency 'Agentschap voor Geografische Informatie Vlaanderen (AGIV)' acts as a permanent technical executive body. GIS-Vlaanderen started in 1995 on an informal basis and was consolidated by a regional decree in 2000. SDI-development is not explicitly part of the mandate of GIS-Vlaanderen but it is implicitly through its coordinating and stimulating role regarding spatial data production, standardisation, documentation, dissemination and sharing;

The implicit Flemish RSDI was compared with other European National and Regional SDI (Van Orshoven et al, 2004; Vandenbroucke, 2005) and assessed regarding a set of defined INSPIRE-obstacles and INSPIRE-principles (Van Orshoven et al, 2003, 2004; Vandenbroucke, 2005). From this comparison it could be derived that the Flemish RSDI is relatively advanced in Europe since it succeeded in creating a noticeable change in the availability of GI within the public sector, but also for service providers from the private sector. Especially the establishment of the permanent technical secretariat (OC GIS-Vlaanderen) and of a multi-level, multi-public steering committee and the presence of advisory bodies in which almost all categories of users are represented, was considered to be a strong point. At the technical level the availability of an attractive and frequently visited web geo-portal was appreciated. However, no clear strategy for the solving of many organisational problems, for the further technical development of the RSDI with a view to realise the full potential of the RSDI is available.

5. STRATEGIC RESEARCH QUESTION

5.1 Research question

An SDI is the relevant base collection of technologies, policies and institutional arrangements that facilitate the availability of and access to spatial data. From a technical point of view, the evolution from separate GIS-systems to SDI consists of the integration of data and technologies of different GIS into one interoperable network. This network is not a static end-product but a space and time independent continuum.

The strategic research question can be formulated as:

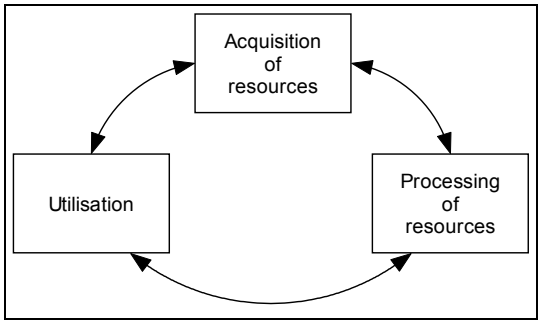
What are the technical, legal, economic, sociological and public administrative requirements to further develop an operational Flemish Spatial Data Infrastructure consistent with international standards that is efficient, effective, flexible and feasible?

This research question contains two components: the development of an SDI and its performance. Both components will now be further elaborated.

5.2 Development of an SDI

In the development of GIS three phases can be distinguished: (1) the acquisition of resources (e.g. technology and data), (2) the processing of resources and the (3) utilisation. The key issue in the development of an SDI consists of integrating these development phases according to the needs and ambitions of different partners and to ensure that the partners' own GIS projects gain from this integration.

Figure 1 - Three cyclical and iterative phases



These phases are cyclical and iterative. The iterative nature of the development and implementation process implies that precedent steps may be readdressed or redesigned. Importantly, this developmental trajectory on the other hand implies a certain degree of path-dependency, in that preceding steps in the process pre-structure the available options and accessible alternatives in following steps.

In the first phase ('acquisition of resources') each resource that is more or less necessary for an adequate evolvement of the process needs to be acquired. Within each of these resource domains obstacles and limitations may have to be overcome. Because of the scale and the complexity of the technology adopted and its non-technological context, these resources are likely to be extremely heterogeneous in nature. Technical, professional, legal, economic and institutional resources may not be readily available in a desirable extent. Resource shortages may range from the knowledge and expertise of human resources within the organisation or derived from the labour market, technological resources derived from commodity markets, financial resources derived from private and/or public funding, to regulatory power resources, or services such as consultancy or education and training. Problems that may arise at this stage are many. Particular for an SDI is also the input of spatial data, which are available in large numbers, but which often are not in digital form, and lack completeness and mutual consistency regarding geometry, attributes, storage formats, etc.

In the second phase ('processing of resources') the challenge is to combine the required and available resources into an adequate configuration. In this process existing boundaries across resource domains may have to be crossed for the attainment of synergies and coherence in the development process. Failures within a specific domain, as well as cross-boundary failures, may significantly reduce the impact of the project as a whole, or may even prohibit the attainment of the project's objectives altogether. The heterogeneity of these configurations will be apparent from the combination of technological aspects or elements, with institutional and economic stakeholders, private sector partners

and civil servants within the constrained setting of public administration. In this phase, these heterogeneous actors will have to be reconciled in relation to several technical stages of developing the information technology system: design, architecture, programming, implementation, operation and support. Because of the qualities inherent to SDI technology any inconsistencies in the various source-data will moreover be clearly revealed.

In the final phase ('utilisation') the attainment of the envisaged goals of the project is ultimately tested in the actual utilization of the project's output. In this phase, not only the utility characteristics of the output can be evaluated, but also more general outcomes such as the eventual discrepancy between the target group that was envisaged before hand, and the group of users and stakeholders that was eventually attained. This is, for instance, related to issues such as the fragmentation or compartmentalisation of public service delivery. Equally relevant are, for example, issues related to the legal value of supplied information, issues of accountability, the user profiles and the economic and social benefits of processing and diffusing data by means of an SDI, which in turn is related to the uptake of SDI-supplied geo-information by intended and unintended target groups, and so on.

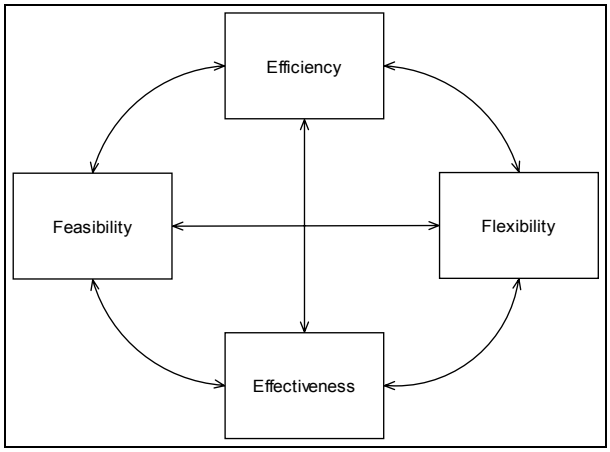
In summary, the specific qualities and characteristics of these stages in the development and implementation process of an SDI constitute the research backbone of this project. The research analyses this process in unprecedented detail in order to identify the determinants of the ultimate outcome as well as to assess how specific development paths correlate with specific outcomes. In doing so, the 'development- and implementation-project' is chosen as primary unit of analysis, and defined as the process of developing, implementing and employing a Spatial Data Infrastructure in public administration. Defining the unit of analysis in such a broad fashion allows us to combine so-called 'source-based stage models', based on the innovation developer or source, and 'user-based stage models', based on the perspective of the user (Klein and Sorra, 1996). In other words, taking the entire cycle into focus implies that the initial design as well as the ultimate employment of an SDI is taken into account.

5.3 Performance of an SDI

Besides the central and self-evident performance-criteria 'efficiency' and 'effectiveness', we would, however, add 'feasibility' as a third criterion. Whereas efficiency would apply to the cost of the way in which given resources are processed, and whereas effectiveness points to the manner in which these resources are succeeded in delivering the required services, 'feasibility' refers to the availability of the needed resources in every step of the way. A final complementary criterion, which is highly relevant in developing SDI's, yet often

neglected, is flexibility. Instead of aiming at the availability, velocity or objective-orientation of resources, the notion of flexibility stresses the adaptability of resources and processes.

Figure 2 - Four-dimensional variables of performance



Our approach thus contends that performance is best defined as consisting of four distinct, yet interrelated dimensions. It should be noted, specifically in relation to the unit of analysis, that these four measures of performance primarily pertain to the development and implementation process (the 'project'), rather than the more narrow conception of performance in terms of attainment of the desired – or desirable – goals[1].

These dimensions are moreover interdependent and likely to reinforce each other mutually. For instance, flexibility may significantly contribute to all other performance measures as it provides opportunities to reshuffle resource configurations in order to enhance performance on all measures. Conversely, increased efficiency may get the process 'ahead of plan', and might thus provide room for manoeuvre (organisational 'slack') that is beneficial for flexibility and feasibility that allows for innovation and experimentation. Effectiveness may, in turn, have a mobilizing effect in that it creates more organisational goodwill, which in turn may yield positive effects in terms of the feasibility of additional projects and extensions of the SDI. Although it can be logically inferred that these dimensions of performance will covariate to a considerable degree, they may also

[1] Obviously, the broad and the narrow conceptions of performance are expected to covariate fully. While the concept of effectiveness can be measured in every phase or step of the development process, the output and outcome of the project can be seen as sub-indicators of effectiveness, notably effectiveness at just one delineated moment in the entire process.

vary autonomously to a certain extent. Although feasibility, efficiency, effectiveness and flexibility set limits to each other's variation, they can simultaneously be dealt with as independent indicators or variables. More specifically, by zooming in on a specific sequence at a delineated moment in the process, certain trade-offs, e.g. between on the one hand performance in terms of flexibility, and on the other hand performance in terms of efficiency, may become apparent.

6. ANALYTICAL RESEARCH MODEL AND STRATEGY

6.1 Analytical research model

The three phases in the development of an SDI (resource acquisition, processing of resources and utilisation) have to be further refined to guide the research. Refining this cycle and iteration will fit an analytical and synthetic purpose.

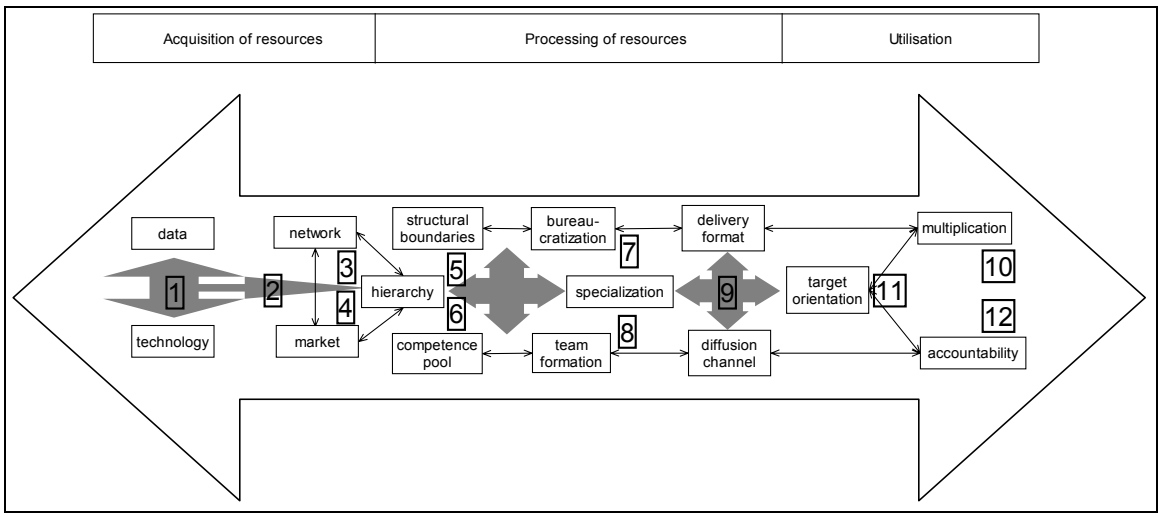
Analytically, the concepts and their links will travel across the disciplinary boundaries, will match theoretical reflections and deductive reasoning, will guide operationalisation for inductive reasoning and empirical testing, and ultimately will determine the substance of variables for future strategies, scenarios, and tactics of implementation.

Synthetically, the dynamics of interactions allow us to describe, explain and predict interdependent and change (static, comparative static and dynamic). Path dependency will be a useful model for the cyclical and iterative nature of SDI development.

The analytical model cannot be seen as technological deterministic, nor is it an organizational deterministic model. The development of an SDI is seen as a process in which different components (technological as well as organizational) interact with each other. The analytical model is not a mechanistic or causal model, but a dynamic and cyclical model. The model tries to visualize the interdependencies between the resources (e.g. technology), processing of resources (e.g. bureaucratic organizations) and utilization (e.g. outputs and outcomes of an SDI). The project starts with a static analysis of all the components in the model, but also analyzes the development of an SDI in a comparative static and dynamic way.

Figure **3** shows the analytical model which guides the operationalisation of this project.

Figure 3 – Analytical model



In the analytical model, four modules are identified: resources module; process inflow module; process outflow module; and utilization module. In each module, a set of issues has been defined in cooperation with a user group consisting of Association of Flemish Cities and Municipalities, City of Leuven, Association of Flemish Provinces, Co-ordination Cell Flemish e-Government, AGIV, IncGEO, National Geographic Institute on a seminar in Leuven 13/12/2005. The issues are listed in the boxes below. Each issue is identified with a number that corresponds with the numbers in Figure 3.

These issues are studied interdisciplinary taking into account the disciplines of public administration, sociology, law, economics and geomatics in order to guarantee a comprehensive view on the development of an SDI. The issues and (inter)disciplinary tasks are allocated among the research groups each representing a specific discipline. The following research groups are involved:
- Public Management Institute (in Dutch: Instituut voor de Overheid) of the Katholieke Universiteit Leuven which has expertise in the areas of public administration, management and policy.
- Spatial Applications Divison Leuven (SADL) which has expertise on SDI, GIS and Earth Observation.
- ICRI (Interdisciplinary Centre for Law & Information Technology) of the Katholieke Universiteit Leuven which has expertise on ICT-law and legal informatics.
- Section 'Sociology of Work and Organisation' of the Katholieke Universiteit Leuven which has expertise on major issues in relation to organisational design and change, economic and industrial development, (the quality of) work, and internal and external labour markets (cf. organisation of work and division of labour).

- Department MOSI of the Vrije Universiteit Brussel which is specialized in complex project and policy-evaluations, whereby decision-makers, both in firms and in public agencies are faced with multiple stakeholders and multiple objectives that need to be taken into account

Resources module

In the resources module, key concepts are 'data' and 'technology', including their legal, organisational, and economic implications. Resource acquisition is coordinated through hierarchies, markets or networks.

Issues:

1. Data and technology: compatibility, interoperability and data formats
2. Data and technology: funding strategies and ownership
3. Network, market, hierarchy: make or buy
4. Network, market, hierarchy: coordination of intra and interorganisational exchange of resources

Process inflow module

At the process level there is an inflow module which allocates resources and which is determined predominantly by 'structural boundaries' (most often presented by public, private, and not for profit organisations) and 'pools of competencies' (e.g. de jure or de facto responsible platforms of expertise). Inflow interactions are (or are not) co-ordinated by three main mechanisms (hierarchy, networks and markets).

Issues:

5. Network – market – hierarchy – structural boundaries: authentic sources and exchange of information
6. Network – market – hierarchy – competence pools: organisational competences

Process outflow module

At the process level there is also an outflow module which distributes the processed resources. Structured entities or organisations, which in this scheme are labelled as 'bureaucracies' (according to a post-Weberian tradition) will consist of and interact with evolving and sometimes virtual expert teams ('team formations'). These organizations and teams focus and specialize ('specialization'), and need co-ordination to determine fit-for-purpose 'delivery formats' of products and services and 'diffusion channels'.

Issues:

7. Bureaucratisation: adaptation of bureaucratic structures and processes
8. Team formation: (re)allocation of tasks and responsibilities of a team
9. Delivery format and diffusion channel: re-use and pricing of geographic information

Utilisation

Finally, the utilisation module focuses on the following key concepts: 'target orientation' (and ultimately goal attainment which consists of efficiency, effectiveness, feasibility and flexibility), 'multiplication' of SDI services and products, and 'accountability' for the responsibilities of actors involved and related to resource acquisition, allocation, processing, distribution and utility itself.

Issues:

10. Multiplication: side effects of geographic information
11. Target orientation: adoption of SDI
12. Accountability: liability for geographic information

6.2 Research strategy

The objective of the project is to describe and explain the development of an SDI. The focus is on the different phases in the development of an SDI (resource acquisition, processing of resources and utilisation) and the interactions between these phases. Each phase is studied in a static (issues are studied by the relevant disciplines), comparative static (in each phase, the interactions between disciplines are studied) and dynamic (interactions, interdependencies and path-dependencies between the different phases) way. Next, extrapolations are made. Different scenarios are designed that can be judged using a multi-criteria analysis.

The project starts with a zero measurement and quasi-multi criteria analysis. This zero measurement has to provide a description of the current state of SDI practise in the Federal, regional, provincial and local administrations, and has to provide input for the (selection of) the cases. Methodologically, a survey (post or on-line) is used to inquire (a representative sample of) the 308 Flemish municipalities, the 5 Flemish provinces, Flemish inter-municipal cooperation, the ministry of the Flemish Community and its agencies, the National Geographic Institute, the National Institute for Statistics and the federal Cadastre. This zero measurement is repeated at the end of the project, for three reasons. First, in four years, there is an evolution in the development of the Flemish SDI. So, the measurement can be seen as a longitudinal research and to assess progress.

Second, the survey can be refined at the end of the project, based on the research results. Third, the survey at the end of the project provides input for the multi-criteria analysis (criteria, weights, scores).

The cases that are studied in the different modules are rather simple to more complex organisations (e.g. municipalities, associations of municipalities), procedures (e.g. re-allotment of parcels), practices (e.g. outsourcing, PPS), and databases (e.g. database of unbuilt parcels). These cases have to be embedded in the Flemish SDI. At this moment, there are ambitions to create such a Flemish SDI or 'Gronddatabank'. This SDI has to consist of, at least, the following basic mapping units: parcels, addresses and subsoil networks. The selection of cases is based on the results of the zero measurement and in consultation with the user groups, as there, at this moment, is not available an overview of SDI-practices. The case research does not lead to statistical generalisations, as this is the objective of the survey research. The cases are studied through qualitative research.

At the end of the research project, a multi-criteria analysis will be performed. In this multi-criteria analysis several scenarios are evaluated according to a refined set of criteria that is based on the four performance criteria (efficiency, effectiveness, feasibility and flexibility). The weights and scores of the criteria are derived from the survey. The scenarios consists of combinations of different choices, trajectories and path-dependencies that came to the fore during the research. Scenarios can be identified using typologies. Such typologies can contain different dimensions: top-down versus bottom-up (imposed or mutual adjustment), minimalist versus maximalist (span and depth), fast versus slow (acceleration of investments or investments spread in time), proactive versus reactive.

Another typology is the typology of the European Commission Forward Studies Unit: they use a typology containing the scenarios 'triumphant markets', '100 flowers', 'creative societies' and 'turbulent neighbourhoods' (European Commission Forward Studies Unit, 1999). These scenarios can be translated to the public sector as 'holding model', 'autonomous networks model', 'implementation model' and 'reintegration model' (Bouckaert et al, 2002). Translated into a SDI-context, each scenario represents another implementation trajectory.

In research on geographic information systems, several scenarios on GIS diffusion were proposed by Wegener and Masser (1996). Wegener and Masser distinguish the 'trend'-scenario (incremental diffusion of GIS), the 'market'-scenario (geographic information is only available for the most powerful actors in society), the 'big brother'-scenario (geographic information is used for

surveillance and control) and the ‘beyond GIS’-scenario (geographic information contributes to more democracy and transparency).

7. VALORISATION POTENTIAL

The valorisation potential of the research project “SPATIALIST; Spatial Data Infrastructures and Public Sector Innovation” is the positive effect on the development of the Flemish SDI. Many of the challenges of contemporary society, such as protecting the environment, increased security, better transport, socially just or sustainable development, risk management and enhanced service delivery to citizens require geographic information. Yet, the availability of geographic information in practice is far from sufficient.

At this moment, the development of an SDI in Flanders occurs in an ad hoc and fragmented way. Initiatives started on various levels of government. Municipalities, cities, provinces as well as the Flemish region and the Belgian federal level are working on relatively isolated projects. The output of this research project has the potential to speed up the roll-out of an SDI on an operational and strategic level and can generate future policy relevant research on this topic.

The project has a fourfold valorisation potential. First, an SDI will increase the use of new partnerships and relations between the public, private and not-for-profit sector (multi-actor). Second, the Flemish SDI will be developed in a multi-level context. So, the project results will be useful for a whole range of actors. Third, research results will not only be applicable to spatial data infrastructures, but to data infrastructures in general. Moreover, the development of an SDI can improve the integration of data and information from different policy sectors. An SDI is also necessary for the further development of e-government and the innovation of public policy and public service delivery. Fourth, an SDI is not an end in itself, but an enabling infrastructure that will enable a range of functional services in the public and private sector.

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