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# Assessing Geographic Information Enhancement*

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## Abstract

Assessment of geographic information infrastructures (or spatial data infrastructures) is increasingly attracting the attention of researchers in the Geographic information (GI) domain. Especially the assessment of value added GI appears to be complex. By applying the concept of value chain analysis to GI, this paper provides a research framework for unambiguously assessing GI value adding. The paper details the enhancing process that must be employed to turn raw geographic information into new services and products regardless of the organisation performing the enhancement. Not only the differences in technical characteristics of data sets are identified, also the roles in a value chain of government organisations and commercial organisations were explored. The framework is applied to two types of GI in the United States and Europe. The presented research shows that the framework allows for true comparison of GI enhancement in different jurisdictions. This should result in better understanding of the level of GI enhancement in a specific jurisdiction and accordingly in effective decisions stimulating GI enhancement, geographic information infrastructures and information societies.

**Keywords:** Geographic information (GI), value adding, value chain, assessment



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## 1. INTRODUCTION

Information economies are a powerful engine for growth, competitiveness and jobs (The Lisbon Special European Council, 2000). It improves citizens' quality of life and the environment. New digital goods and services are vital to developing information economies (The Lisbon Special European Council, 2000; see also High Level Group, 2004; Commission of the European Communities, 2005; The European Parliament, 2005). Information infrastructures are considered the backbone of information economies (Castells and Himanen, 2002). Within information infrastructures, geographic information may be considered a special type of information. This specialty has resulted in the emerging of geographic information infrastructures (GII). Daratech has estimated the global GI industry to total US$3.3 billion in 2005 with expected annual growth rates of over 10% (Daratech, 2006 cited by Longhorn and Blakemore, 2008; ABI research, 2006; JupiterResearch, 2007). In addition, it has been estimated that eighty percent of all government information has a geographic component (FGDC, 2007; Robinson, 2002). Objectives of GIIs are to provide users effectively and/ or efficiently the geographic information they need (quality, type, scale, among other aspects), in the way the users need it (price, user interface, among others) (Van Loenen, 2006). Value adding services are critical for the GII since they typically bring the information to the broadest range of users necessary for the GII to reach its full potential (Van Loenen, 2009; Crompvoets et al., 2004; Rajabifard et al., 2003).

The stimulation of value added services and products based on public sector geographic information (PSGI) is a prominent subject on the agenda of policy makers in the geographic information domain. It has been estimated that the value adding market of geographic information in Europe is extremely small compared to North America (Pira, 2000). The US geo-information industry was estimated to contribute significantly to the American economy, employing over 3.2 million individuals and generating sales of over €641 billion (Pira 2000, p.50). To arrive at similar figures, Pira advised Europe to change its cost recovery policies for public sector information (PSI) into policies promoting re-use of PSI. In 2008, Castelein et al. (2010) assessed the economic value of the Dutch GI sector to be around €1.4 billion employing approximately 15,000 people. They noted a growth of 17% compared to the 2007 numbers. Extrapolation of these numbers for the Netherlands (16 million people) to a European level (491 million people) results in an economic value of almost €43 billion (cf. MEPSIR, 2006 arriving at a maximum of €47.8 billion). This is only an increase of 20% compared to the Pira figures of a decade earlier. And still small compared to the 2000 US figures.

To bridge the gap, the EU enacted in 2003 a Directive directed at promoting value adding to public sector information (2003/98/EC; PSI directive) recommending policies allowing more extensive re-use of public sector information similar to US federal government policies. Five years after the Directive's introduction, only a few best practices of value adding to public sector information in Europe were identified (see Micus, 2008; ePSIplus, 2009; Corbin, 2008; European Commission, 2008) indicating that the objectives of the Directive have not been reached yet. As a result, the assumed differences in GI value adding activities in different jurisdictions remain unexplained and policies aimed at stimulating value adding to GI less effective than expected.

The approach of the information value chain, as introduced by Krek (2002) and again by Longhorn and Blakemore (2008), is a promising approach to explain the differences in value adding to GI across different jurisdictions (see also Genovese et al., 2010; Genovese et al., 2009; Van Loenen and Zevenbergen, 2006; Krek and Frank, 2000). This approach assumes a value adding process from raw data to a final product or service is accomplished via a number of stages during each of which new value is added to the original input by various activities (Longhorn and Blakemore, 2008 referring to Porter, 1985). Value is created step-by-step along the chain (cf. the supply chain in Cox, 1999; Beamon, 1999; Lambert, 2000; Manthou et al., 2004).

**Figure 1: The Value Chain Concept**


In this paper, we detail the enhancing process that must be employed to turn raw geographic information into new services and products regardless of the organisation performing the enhancement. Not only the differences in technical characteristics of data sets are identified, also the roles in a value chain of government organisations and commercial organisations are explored. Such a framework may explain the differences in value adding activities for GI in different jurisdictions.

In Section 2 we will address the general term of value of geographic information. Section 3 describes theoretical models that may be used to assess the value of geographic information and explains the assessment framework that was the bases for the accomplished case study research. Section 4 presents the case study and its results which are analysed in Section 5. Section 6 concludes this paper.

## 2. VALUE ADDING TO GEOGRAPHIC INFORMATION

Value is a subjective term with many meanings and the same applies to *value adding*. The difference in the meaning of 'value adding' may explain the discrepancy between the 'value added' markets in the US and EU.

Value is a term that is difficult to define. You may ask a hundred people how they value their navigation system and you may get a hundred different answers. Crompvoets et al. (2008) arrived at a similar conclusion when assessing different national spatial data infrastructures (SDIs). Without a sense of the value of geographic information, it is impossible to define *adding* value to geographic information.

### 2.1. Value Components

Longhorn and Blakemore (2008, ch. 2) systematically researched different components of the value of geographic information. They identified:

- value of the location attribute (e.g., non-geographic information added to geographic data);
- value of time dependency (value changes over time: e.g., traffic information);
- value due to cost savings;
- value due to giving data a legal status (e.g., parcel boundary);
- value due to network effects (e.g., ubiquitous use);
- value due to quality of a data set (e.g., accuracy, timeliness).

Adding value may then be defined as adding to one of these components. For example, adding an attribute to a geographic data set, providing immediate access to real-time data, reducing costs involved in processing the data set, giving a data set a legal status, increased use, improving the quality of the data set (adding meta data, improving update frequency, improving the accuracy). The last may also involve the integration of several data sets into one (see STIA, 2001, p.9-4).

In addition to the value components, Longhorn and Blakemore (2008, ch. 2) also identified concepts of commercial value, economic value and socio-economic value. Porter (1985 cited by Krek 2002) defines value as "the amount buyers are willing to pay for what a firm provides them". Value is then measured by the total revenue of the firm (price times the total number of products sold). Pira (2000) and Longhorn and Blakemore (2008, ch. 2) consider this the commercial value.

From their work we understand that Longhorn and Blakemore (2008) consider the economic value the revenues and the number of people employed by the GI sector, and socio-economic value would also include non-commercial values, such as improving informed decision-making. Krek (2002), however, defines economic value as the difference between acting with and without the information. This would define adding value as adding more revenues, employing more people, and/ or improving informed decision-making.

Measuring just revenues would ignore value from adding by public sector bodies executing their public task. Measuring the employment of people in the GI sector is extremely difficult since the GI sector is not administered as such, however (see Pira, 2000; cf. Castelein et al., 2010). Similarly complex is the assessment of the improvement of a decision due to the use of GI (cf. Krek, 2002 attempting to do this through simulation of a simple decision using one type of GI). The value one type of information has for one type of use(r) may be different for other use(r)s. What if an assessment involves multiple types of data sets, multiple users with different tasks that require different combinations of different types of data sets? For example, the data sets most wanted by Dutch businesses (Groot et al., 2007) are different from the information needs of emergency response teams (Dilo and Zlatanova, 2008). Assessing the commercial, economic, and socio-economic value of GI comes with significant uncertainty and bias (see also Longhorn, 2006; Craglia and Nowak, 2006).

Assessing the value from a user perspective assesses what the information adds to one’s decision. This is what Krek (2002, p.22) calls the functional value. She adds the cognitive value, an emotional value, of a product: it feels good, the brand name suggests value. Also assessing functional value has the difficulty of subjectivity.

An unambiguous way of looking at value of GI is assessing it from a product perspective. This approach looks at the (technical) characteristics of the product: what are the functionalities, how comprehensive is the content, and how easy is it to use? In this paper we will use this product perspective to compare the value chain of two data sets in the US and three countries in Europe. For reasons of clarity we will call this assessing GI enhancement.

## 3. ASSESSING ENHANCEMENT OF GEOGRAFIC INFORMATION THROUGH VALUE CHAIN ANALYSIS

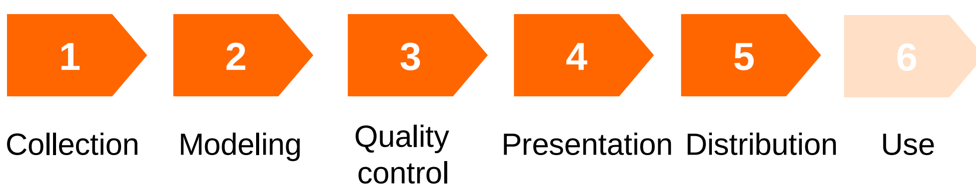
According to Porter (1985) a production value chain involves the progress of goods from raw materials to finished products via a number of stages, during each of which new value is added to the original input by various activities. “If the value, or price, of the outputs at any stage is higher than the value, or cost, of inputs at that stage, then value has been added, resulting in a profit margin earned within that stage. The sum of all such margins, at the end of the chain, equals the total added value.” (Longhorn and Blakemore, 2008, p. 38-39). Applying the value chain approach to GI provides a clear systematic approach providing insight in differences in geographic data and service characteristics among different jurisdictions.

### 3.1. Geographic Information Enhancement Chain Analysis

Provided the many perceptions of the term value, or value adding, has, we use the term GI enhancement to indicate that our analysis is directed at assessing the technical characteristics of geographic information (i.e., a product or data perspective).

The primary base for dividing the chain of a certain product or service into steps is derived from the sub processes of the (geo) data processing. Raw data acquisition, applying a data model to the raw data, performing quality control, presentation and distribution are some of the most essential steps (see Figure 2).

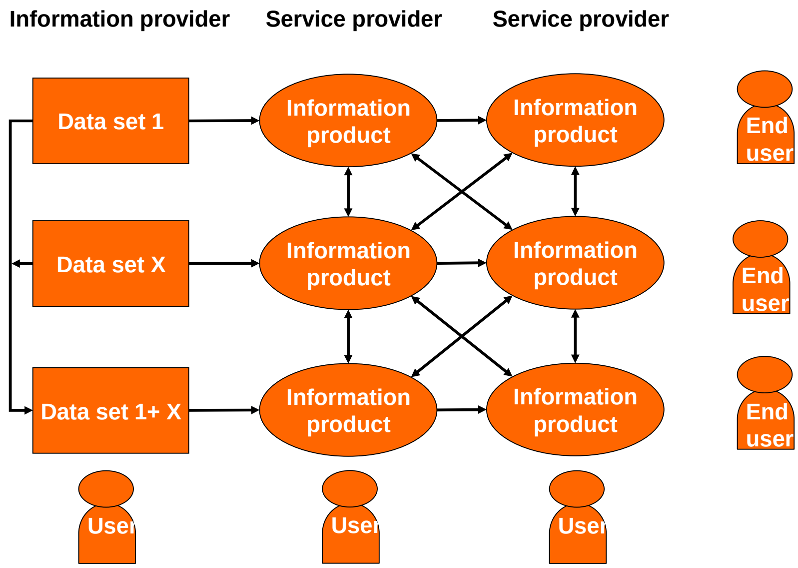
**Figure 2: Example of a Geographic information Enhancement Chain**




Each step enhances the data from the previous step. In each step the GI product or service is made more valuable: new products or services may be developed serving the needs of new groups of users. As a result a chain of new services building on previous services may develop. Also these new services are GI enhancements.

The product or service an organisation supplies, is one step in this chain. It can be the final step, but another product or service can be built on it by another organisation as well (see Figure 3).

**Figure 3: Value Adding Steps Including Services**




The value adding may consist of improving the quality of the data set, integrating several topographic data sets into one layer for a jurisdiction, linking a framework geographic data set with several thematic layers (adding attributes), and preparing the readiness for combining. Other value adding may include providing user-friendly access to the data set (e.g. adding search facilities, explanation, help desk), or intermediary services that help information resources in distributing the data set.

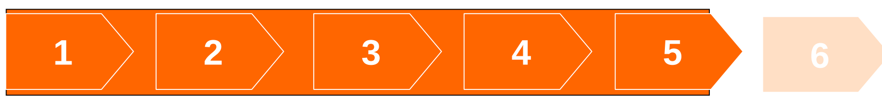
At the end of the value chain, the end-users (citizens, decision-makers, and others using an end-product) are being served by the end-product of geographic information, for example, an animation, a map or a plain answer, mostly through services provided by value-adding resellers (Van Loenen 2006, p.40).

## 3.2. Who Adds Value?

Part of the confusion about the term value adding is caused by the general concept one associates with adding value. Focus is often on the value adding performed by private companies based on the (geo) data set they acquire from a public sector organization (including agencies), without realizing how far in the chain a data set has progressed at that moment.

A simple example may clarify this. Assume two cases A and B and a simple value chain of five steps (see Figure 1). In case A an agency has performed two steps and provides the data set at that point to anyone. A private value adding reseller takes this data set further through the value chain by taking care of steps 3 to 5. In case B an agency performs all five steps and provides the resulting data set to anyone. From an economic perspective, the activities of the private value adding reseller (case A) would typically be considered value adding while the same (value adding) activities of the agency in case B would not (see Figure 4).

**Figure 4: No Value Adding if All Value Chain Steps (Steps 1 -5) Are Performed by One Organisation?**




It is clear that in an abstract way each step provided in figure 4 'adds value' to the data from the previous step. But if all value enhancement steps are going to be undertaken within one organization (company, agency, other), we would normally not use the term 'value adding'. Such a term we would reserve for the cases were a GI data product with a use value, is passed on from one organization to another. Each organization in the chain adds value, and makes a new GI product or service that satisfies the needs of another group of users.

In the next sections we will present several examples of GI for which the first step(s) are set by government agencies to meet their immediate (legal) mandates, but with a very different approach in setting several consecutive steps (including making them digital, and combining data from several smaller areas into one data set of the next jurisdictional tier).

## 4. APPLYING THE ENHANCEMENT FRAMEWORK

In this section we apply the enhancement framework to four cases: road centreline and parcel data sets in both the United States and Europe. Both data sets are considered to be part of the bases for the geographic information infrastructure of the US and European Union (framework data sets) (see Onsrud, 1998; FGDC, 2006; INSPIRE, 2007).

Framework data sets are data sets that are commonly used as a base data set upon which other data sets build (Groot and McLaughlin, 2000; Luzet and Murakami, 2000; Chan and Williamson, 1999; Philips et al., 1999). Without reference to a framework data set the wider use of other information is often limited. With respect to value-added use, Micus (2001, p.12) noted that the value of framework information increases with the number of services added to the information.

We assume that this implies that these data sets are of equal importance for the performance of the respective SDIs and the needs for these data sets are similar on both sides of the Atlantic ocean.

For this paper we took another look at the case study results of the five jurisdictions described in Van Loenen (2006). In that study we compared jurisdictions with similar socio-economic development, system of government, and geography (size of the jurisdiction/ population density). The five jurisdictions selected were the Netherlands, Denmark, Northrhine-Westphalia (Germany), Massachusetts (US) and the Metropolitan Region of Minneapolis and St. Paul (US).

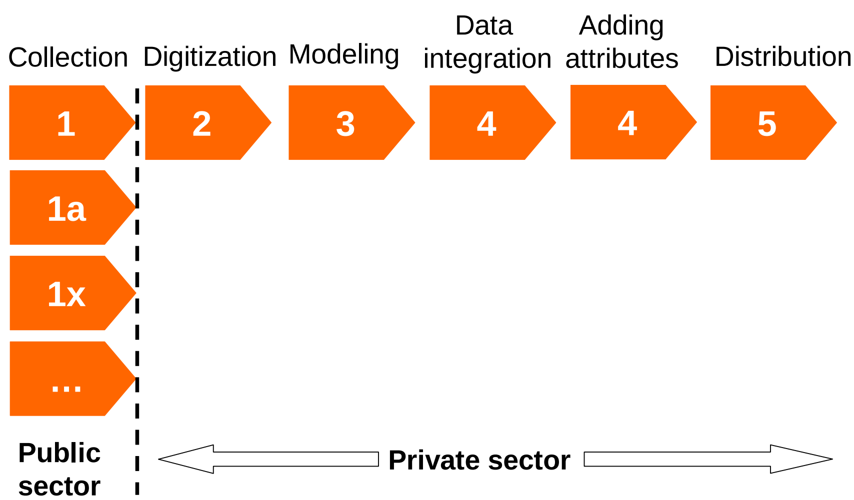
### 4.1. Road Centreline Data Sets

#### *4.1.1. United States*

In the US, the road centre line data set is the freely available TIGER (Topologically Integrated Geographic Encoding and Referencing system) data set. The TIGER data comes from a variety of sources, mainly the US Geological Survey (USGS)'s 1:100,000 topographic maps. The positional accuracy varies with the source materials used, but generally the information is no better than the established national map (a maximum positional error of 167 ft (i.e. 51 meter)) (http://www.census.gov/cgi-bin/geo/tigerfaq?). Update frequency varies heavily throughout the country. It is assessed that the TIGER files are not suitable for high-precision measurement applications such as engineering problems, property transfers, or other uses that might require highly accurate measurements of the earth's surface (Source: metadata TIGER files).

In several instances better road centrelines are developed at a local level. Several public entities in Minnesota create road information. The state department of transportation has the major roads (highway to city level) in their database. Each county has some version of road information, but they generally do not maintain address attributes. Private roads are also generally not included in these public data sets. In the Metropolitan region of Minneapolis and St. Paul (US), The Lawrence Group builds on the data sets provided by local government, among others. The Lawrence Group either digitizes street centre line data from paper maps from local government or obtains it in digital format through a partnership arrangement. They adjust the data to match coordinate geometry information from the counties. The private company further improves these data sets, aligning them and adding addresses (geo-coding). Updates are available every three months. The private company's goal is to have 95% of roads located within the approximate centre of digital right-of-way data or pavement centrelines provided from counties, where such digital data is available. In other areas, 95% of roads are intended to be within ten meters of the road or right-of-way centre.

**Figure 5: Value Chain of Road Centrelines in Metropolitan Region of Minnesota and St. Paul (US)**

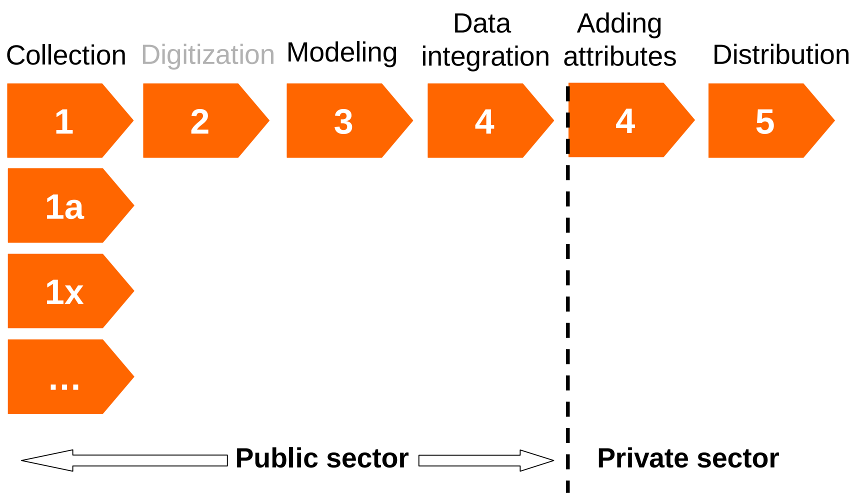



*4.1.2. Europe*

In Europe, no public road centre line data set covers Europe entirely. However, many countries have their own road centreline data set available for the entire jurisdiction. In Denmark, the public sector developed it based on the *Tekniske korte* (1:1,000-1:25,000). Its update frequency varies from 1 to 6 years. In the Netherlands, the *Top10NL* (1:10,000) of the Dutch *Kadaster* (and also the National Road Data set (NWB-roads) of the Ministry of Transport, Public Works and Water Management) provide road centrelines for the entire Netherlands. Both data sets are public data sets. The NWB data set is the result of integrating road data from local, provincial and national government bodies. It is updated on a monthly basis.

In Europe, the value enhancement of creating a high quality road centreline for an entire country has been in the public sector. In Minnesota, the activities of The Lawrence Group are considered value adding on the core public datasets.

**Figure 6: Value Chain of Road Centrelines in the Netherlands and Denmark**




## 4.2. Parcel Data Sets

Another example of private sector value adding in the US for a product that is provided by the public sector in Europe, deals with the parcel (cadastral) information. Parcel data sets are typically part of the local government responsibilities in the US while in Europe it is often a central government task. The impact this may have on data characteristics is explained in Van Loenen and De Jong (2007).

Table 2 shows some core data qualities found in the five cases (see for detailed information Van Loenen, 2006). Again, it shows that in the European cases higher quality datasets are available. Especially concerning the consistency in the data sets the European data sets score very well. The MetroGIS' data sets compares on many aspects (except for content) very well with the European data sets.

**Table 2: Core Data Characteristics for Parcel Data Sets in Case Studies**

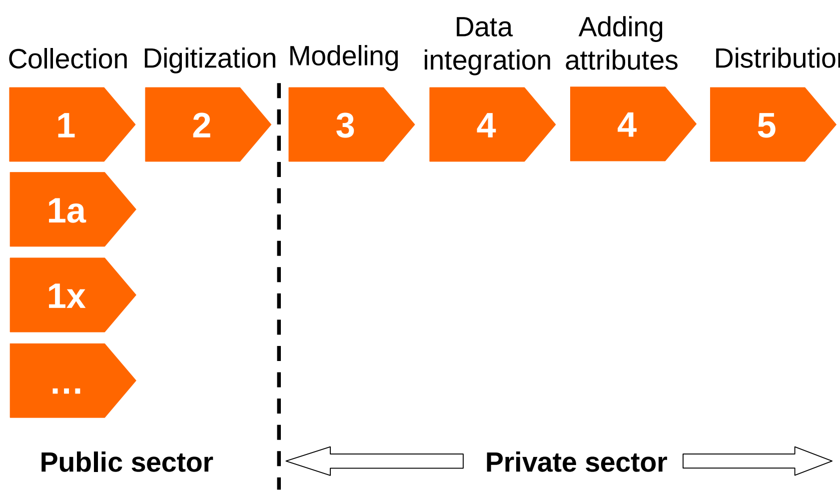
| Quality | Denmark | Nether-lands | Northrhine Westphalia | Massachu-setts (public) | Minnesota (MetroGIS area) |
|---|---|---|---|---|---|
| Digital coverage | 100% | 100% | 87% | 66% | 100% |
| Currency (years) | 1-2 | 1 | 1 | varies from non-existent to 1 year | 0-2 |
| Content | core-comprehen-sive | core-comprehen-sive | comprehen-sive | limited- core | limited |
| Coordinate system | national | national | national | local/ state | state |
| Pos. accuracy | cm-m | cm-dm | cm-dm | meters | dm-meters |
| Data model | jurisdiction wide harmonized | jurisdiction wide harmonized | jurisdiction wide harmonized | state/ none | jurisdiction wide harmonized |
| Metadata | comprehen-sive | none | none-comprehen-sive | none-comprehen-sive | comprehen-sive |
| Quality consistency throughout (integrated) data sets | high | high | high | none | reasonable |

## 4.3. Value Adding to Parcel Data Sets

In the US at least one company, Boundarysolutions (www.boundarysolutions.com), sells 76 million parcels, of 680 jurisdictions in the US for $0.005–$1.00/parcel per year (specified in a license). The private company has normalized the government parcel data sets to a single national spatial configuration. eMap International has sacrificed a similar effort to convert every land parcel in the dataset into a standardized delivery format and to rectify it against DOQQ imagery. This dataset includes parcels digitized from paper maps and parcel information from digital files with no geographic structure (source: http://www.emap-int.com/products/Parcels/index.html). First American Proxix Solutions (http://www.proxix.com/Products/Data/Tax/) claims to have a similar product, linked to all kinds of tax information. In Figure 7 these efforts are summarized as bringing together different public sector sources, harmonizing and integrating them and distributing a new product.

Figure 8 shows that some companies are only using one step in the value chain: they add value by re-distributing public sector information with its original technical characteristics. For example, Zillow (http://www.zillow.com/homes/map/map-and-search_rb/), a real estate agent, provides access to information for 70 million US parcels in one viewer (Coleman, 2007). Another private company brings together many local government parcel information in New England (6 US states). Most of them are freely available through http://www.visionappraisal.com/databases/mass/index.htm. Some of these states have their own access point for the land registry (see http://www.masslandrecords.com/malr/index.htm).

**Figure 7: Value Chain 1 of Parcel Data Sets in the US**




In Europe, these US private activities are typical public tasks. Most European cadastres are the only access point for an entire country, and provide standardized ubiquitous parcel data. In addition, it is the public sector in Europe that has initiated a project to bring together data from cadastres and land registers throughout Europe in one portal (see the European Union Land Information Service, EULIS; http://www.eulis.org). In the US, the Land Records Inventory provides a map based index of states, counties and cities that serve cadastral or parcel level information on their web sites (see http://www.geodata.gov and http://www.nationalcad.org).

**Figure 8: Value Chain 2 of Parcel Data Sets in the US**

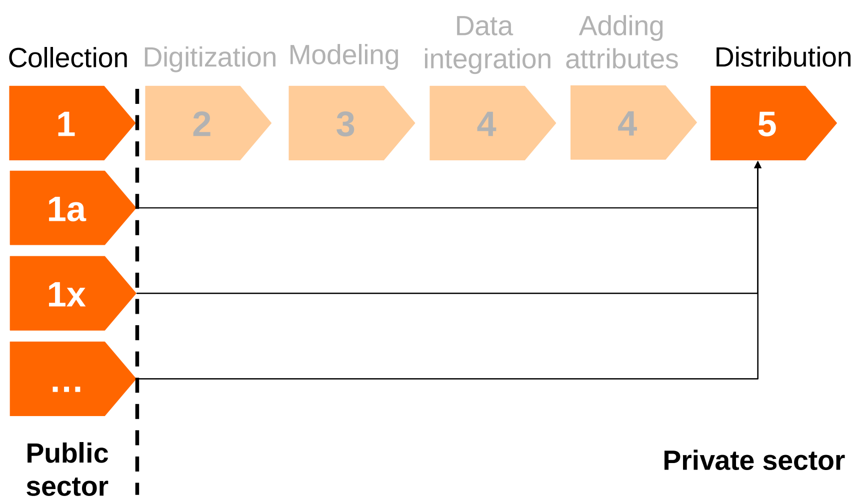
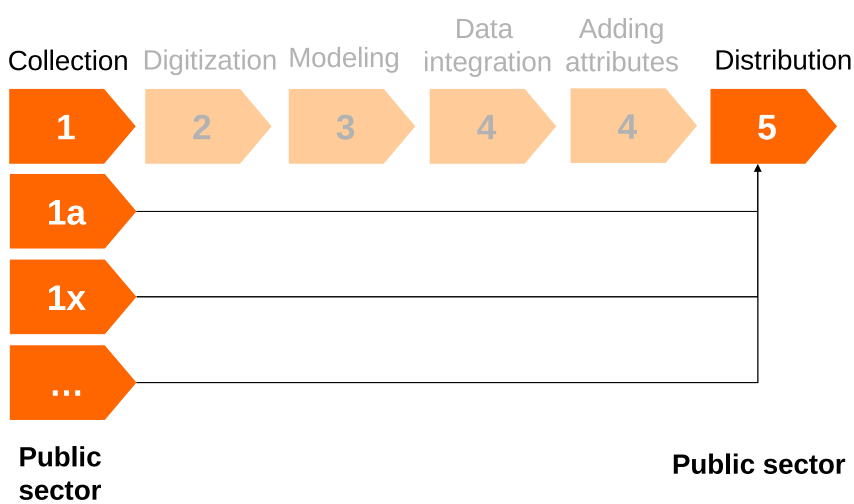



**Figure 9: Value Chain of Parcel Data Sets in Europe: EULIS**

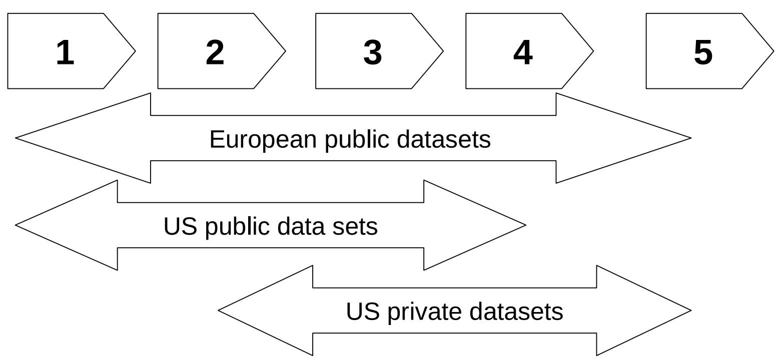


## 5. ANALYSIS

Applying the information value chain theory to two important types of geographic information, road centre lines and parcel data sets in Europe and the US, suggests that one explanation of the difference in value adding to PSGI in Europe and the US may be found in the ambiguous meaning of the wording value adding to GI (see Longhorn and Blakemore, 2008, p. 40). It is likely that what in one country is considered a value adding activity may not in another.

Our research has found significant differences in the geographic information characteristics of governments in Europe and the US: European public sector GI was more accurate, more up-to-date and more comprehensive. This resulted in confirmation of the proposition that the private sector in the US adds value to US public sector GI to arrive at similar levels of quality and service provision as provided by the public sector in Europe (see Figure 10, Van Loenen and Zevenbergen, 2006; see also GITA, 2005; Lopez, 1998).

**Figure 10: A Preliminary Summary of 'Value Adding' in the Case Studies**




The information studied here is a small sub-set of available geographic information in Europe and the US. And within the sub-set, we have only looked at a very small number of cases, which may not represent the entire US or European situation concerning enhancement of framework data sets. However, the findings provide us with the indication that it is the data sets available in the US private sector rather than those in the US public sector that are comparable to European public data sets with respect to the level of enhancement of the two studied framework data sets. From an economic perspective, the European public sector enhancement activities are not likely to be recognised as value adding, but rather considered to be part of their public task.

Although this research did not address the causes for these differences between Europe and the US, several suggestions may explain them. It may very well be that in Europe access to raw geographic data is limited or not possible, which may prevent private sector to add value to the data. Prices of PSGI may also be assessed to be too high to develop value added products on PSGI. Also historic developments, especially related to the role of government in a GI value chain, should be taken into account if the causes for the differences are to be researched.

## 6. CONCLUSION

Our research shows that value adding is influenced by the different roles government and market play in the GI enhancement chain. The different roles impact on the appropriation of value flows to the players in the chain. Research addressing the roles of different parties within a chain is scant, especially in international comparative research (see, for example, Pira, 2000).

Therefore, the reliability of the assessment of the value added GI market, such as Pira (2000), was questioned. Provided the many perceptions the term value, or value adding, has, we used the term GI enhancement to indicate that our analysis is directed at assessing the technical characteristics of geographic information.

Using a GI enhancement analysis indicates that it is the data sets available in the US private sector rather than those in the US public sector that compare with European public data sets with respect to enhancing framework data sets. From an economic perspective, the European public sector enhancement activities are not likely to be recognised as value adding, but rather considered to be part of their public task.

So applying the information value chain theory to two important types of geographic information, road centrelines and Parcel data sets in Europe and the US suggests that the lack of success of the PSI Directive may be found in the ambiguous meaning of the wording value adding to GI. It is likely that what in one country is considered a value adding activity may not in another.

Using the results of case study research in the United States, and the European Union for transportation network and parcel data sets, this paper demonstrates the need to link the GI enhancement chain to the roles different parties play in this chain as a prerequisite for delivering objective and valuable information that can be used for comparing GIIs across jurisdictions.

Use of the GI enhancement approach should result in better understanding of the level of GI enhancement in a specific jurisdiction and accordingly in effective decisions stimulating GI enhancement, geographic information infrastructures and information societies.

One outcome of a value chain analysis may be the extent to which a chain delivers value added products. Applying such an approach across different jurisdictions may provide insights in the performance of GIIs compared to each other.

To be of use for policy makers, GI value adding in jurisdictions needs to be validated empirically through a research framework addressing the term value or value adding unambiguously. We argue that GI enhancement meets this criterion from a product perspective.

Comparing the technical characteristics of the data sets available in the public and private sector may reveal what level of GI enhancement exists in a jurisdiction and what the distinguishing roles of government and private parties in the enhancement are and to what extent value flows are appropriated to these parties. This step is critical in the assessment of the value of geographic information in general and the value of geographic information infrastructures more specifically.

## 7. FURTHER RESEARCH

The research found evidence that in local government in the US and in the European cases topographic datasets are used at different levels of detail and currency. In general, less detail was used in the US than was the case for the European counterparts, even though the population density, the overall population, and geographic size were of the same order of magnitude.

It would be interesting to investigate whether European countries are working with datasets that have too much detail, or whether the local governments in the US do not use enough geographic detail, which can result in poorer decisions. Is the need for geographic information for the densely populated local levels in the US similar to the needs of densely populated areas in Europe? And is the role of local governments in the US as comprehensive as comparable levels of government in the European cases? Or are European government employees too demanding with respect to their information desires; is it possible that less comprehensive and less detailed datasets would satisfy their needs?

Moreover, this research has focused on GI enhancement steps in two separate value chains. It did not study the relation between these chains and their relation with other value chains. It would be worthwhile to look at the impact of the separate steps of these chains on associated chains and the direct or indirect impact a change in one chain may have on value appropriation in associated chains.

Further, future research may compare and discuss the question what the market and what the government should see as their respective roles. In this respect also the increasing importance of volunteered GI and its influence on the roles of government and the market in value chains is an area which should be further researched. Equally interesting is the potential impact of what we found on the development of GII.

The prospects for the GIIs in Europe look more promising with increasingly policies promoting the re-use of high-quality geographic information (see for example, the policy changes of the Cadastre in Spain, Provinces and Water authorities in the Netherlands, the Irish Department of Communications, Energy and Natural Resources, the Cadastre in Austria, and Ordnance Survey in the UK), while in the US the NSDI relies for a major extent on the quality adding activities of the private sector, which in return often allows access only at restrictive conditions.

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