Demand-driven improvement of government geodata

How digitization can help increase quality of and societal benefits from spatio-legal data

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Abstract

Data from government registers is increasingly being used digitally. Data is often used for purposes it was not originally intended, and this challenges data quality. Digitization supports easy and quick flow of information across distance and time, allowing for a rethinking of traditional ways of solving tasks. Utilizing well-known digitization trends in processes maintaining geospatial data can help increase quality of and societal benefits from such data. For geospatial data that is used or created in an environment based on legislation – so-called 'spatio-legal data' – trusted players could contribute to this. However, rules and processes associated with registers hosting spatio-legal data often prevent this. This article presents a new model for how demand-driven improvement of quality and maintenance of geospatial data can be achieved, and how trusted players – such as land surveyors – could play a role when it comes to spatio-legal data.

Keywords

spatial data infrastructure (SDI); volunteered geographic information (VGI); digital platform; demand-driven improvement of geospatial data; authoritative geodata; spatio-legal data.

Introduction

'Data is the new gold' is a popular statement that captures an important aspect of the digital agenda. In the public sector, digital government is in focus, and access to good and reliable data is crucial both when processing individual cases and when working with analysis and planning tasks. Extensive measures have been taken to make the content of existing government registers more widely available with the aim of supporting quality and transparency in public administration. On the European level, several European Union initiatives pursue this with the Directive on open data and the re-use of public sector information (*European Parliament and Council 2019*) as a recent highlight. The same development is supported by national initiatives such as the data.gov.uk (*UK Cabinet Office 2012*) in the UK and the Basic Data Programme (*Danish Government 2012*) in Denmark.

Developments have revealed that data quality (defined as completeness, thematic accuracy, logical consistency, temporal quality, positional accuracy, and usability) and the form in which data is available (e.g. as text or drawing in PDF documents vs. as digital objects) is a problem for many registers, and that comprehensive measures are needed to improve the quality of data so that digital use is supported satisfactorily. Most of the funds in the two-billion Danish kroner Danish Basic Data Programme was thus used to improve the quality of data in the basic data registers, a task that was handled by the authorities responsible for the registers. Significant resources must also be used in the future to maintain and improve the quality of data, both basic data and other data. When doing this, it is a challenge to prioritize quality improvement and maintenance activities due to the fact that the value of data often occurs externally to the authorities that – on the basis of budget appropriations and without close relation to data's external value creation – are tasked with the quality improvement and maintenance activities.

The aim of this article is to answer the question of whether a more appropriate way can be suggested to carry out the quality improvement and maintenance activities. The research question that will be investigated to come up with an answer is:

- Can a new business model for how geospatial data is quality improved and maintained make an environment where:
    - activities are demand-driven,
    - resources are scaled to meet demand,
    - financing is tied to value creation, and
    - data handled via the model can be trusted?

The article will use a review of existing literature and practice to conceptualize a model that answers this question. The article is structured as follows:

- **Background and literature review** investigate the current situation and digitization trends.
- **New business concept scheme** suggests a technology-enabled business model.
- **Empirical evidence and practice review** explore the new business concept for a specific type of geospatial data.
- **Findings** discuss how the new business concept as applied in the practice review addresses the research topics.
- **Discussion and conclusions** put the applicability of the findings into a broader perspective.

Background and literature review

Some characteristics of the actual state of implementing spatial data infrastructure (SDI) are briefly reviewed. Two digitization trends essential for the concept presented in this article – *Volunteered geographic information (VGI)* that originates from the geospatial domain, and *Digital Platforms* that originate from the business domain – are also reviewed.

Spatial data infrastructure (SDI)

SDI is defined as "the technology, policies, standards, and human resources necessary to acquire, process, store, distribute, and improve utilization of geospatial data" (*US President 1994*).

Geospatial data comes from many sources and is used within many domains. An efficient use of government resources requires that spatial data is stored, made available and maintained at the most appropriate level and that it is possible to combine spatial data from different sources and share them between several users and applications (*European Parliament and Council 2007*).

Implementing SDI has been a priority around the world for the last couple of decades. Geospatial data is handled as datasets in registers, and processes around the datasets ensure the dissemination and the maintenance of the geospatial data. Advances in sensor and positioning technology allow for collection of data creating still more sophisticated, timely and accurate representation of real-world objects, and advances in communication, storage and processing technology let increased volume of data be utilized, support increased variety of data types being combined, and allow for increased velocity in creating, updating, and analyzing data (*Hansen, Thorben 2018*).

The advance in technology has also enabled changes in the dissemination of geospatial data seen from a business perspective. Traditionally, bodies responsible for datasets – dataset authorities – have a direct relationship with end-user organizations. With applications increasingly employing advanced tools that combine ever increasing amounts of geospatial data from different sources on the fly, a new category of users has evolved: *application suppliers* offering applications to end-users

that utilize data services from multiple dataset authorities. Business models for dissemination of geospatial data operating with end-users, dataset authorities, and application suppliers have been present for some years (*Hansen, Thorben and Hollænder, Jens 2004; Overgaard, Bo and Hansen, Thorben 2008*).

In some countries, the use of geospatial data is subject to payment of license fees. With the use of data from different sources as embedded elements in various end-user tools, this model is challenged as the amounts charged by the data owners often outweighs the perceived value of data in specific applications, and licensing agreements complicate the setup. These barriers turn out to be prohibitive for many use cases where geospatial data could have provided good value. More countries are moving towards geospatial data being open and free at the point of use. This model stimulates the innovation in the private enterprises that use geodata. Case studies show that open geodata have been the factor in new enterprises being established and have enabled already established enterprises to further develop existing products or develop new products (*PwC 2017*).

As described above, the dissemination of geospatial data is undergoing significant changes on the business side when implementing SDI. Similar changes on the business side are not seen when it comes to maintenance of the geospatial data in the SDI that government relies on and is responsible for. Here, the traditional way of handling geospatial data is still employed: data resides in registers where government authorities serve as custodians and as such determines the rules associated with the data and takes care of establishing and maintaining the data contents.

Volunteered geographic information (VGI)

Volunteered geographic information (VGI) is the use of digital tools to collect, analyze, and share geographic information that was provided by individuals.

The internet has fostered an acknowledgement of the ability to share information easily, quickly, and across distance and time, allowing users to play the roles of both information consumer and information producer. This acknowledgement has grown in parallel with significant technical developments in both data collection capabilities, access devices and broadband infrastructure. The result is new approaches to problem solving that combine technologies and the nature of the internet in a way where the result reflects the aggregated knowledge of multiple users.

Geospatial applications are one of the fields where enormous knowledge assets reside in collectives, but until recently remained largely untapped due to insurmountable costs for collection and coordination. VGI offers an effective way in which these knowledge assets can be tapped (*Flanagin and Metzger 2008*).

There are several examples of VGI implementations. The best known is probably Open Street Map, where end-users work together to create a worldwide base map with the road network as the main content element. The VGI concept can also be used to implement a platform that exchanges volunteered data updates on a demand-driven basis to geospatial data in government registers (e.g. spatio-legal data) through an open environment.

However, VGI raises concerns if the credibility of volunteered data – due to the origin of the data – allows it to be accepted as an authoritative source for many of the purposes that government registers are used for. For example, the multiplicity of sources that ensure vast information availability also make assessing the credibility of information extremely complex. Moreover, the origin of geographic information, and thus its quality and veracity, are now in many cases less clear than ever before, resulting in an unparalleled burden on individuals to locate appropriate

information and assess its meaning and relevance accurately. Doing so is highly consequential: assessing credibility inaccurately can have serious scientific, social, personal, educational, and even political consequences (*Flanagin and Metzger 2008*).

Advantages of the VGI model are that data can be kept demand-driven and closely connected to value creation, that quality improvements that arise in connection with processing and use of data in application projects are easily fed back to the registers it originated from, and that there is a link between the value data brings and the costs of maintaining data. Disadvantages of the VGI model are that the incentive for a user to actually bring quality-enhanced data back to the register is not always obvious, and that the credibility of the end-user's contribution to the register content can be called into question.

Digital platforms

A digital platform is a business based on enabling value-creating interactions between external producers and consumers. The digital platform provides an open, participative infrastructure for these interactions and sets governance conditions for them (*Choudary et al. 2016*). Digital platforms allow users to exchange "something of value" and are the basis for much of the new thinking of the business that is happening as part of digitization in recent years.

Traditional pipeline business is characterized by businesses creating value by controlling a linear series of activities – the classic value-chain model (*Alstyne et al. 2016*).

Important differences between digital platform business and traditional pipeline business is that where traditional pipeline business relies on linear value creation, platform business relies on multidirectional value creation; where traditional pipeline business relies on resource control, platform business relies on resource orchestration; where traditional pipeline business relies on internal optimization, platform business relies on external interaction; where traditional pipeline business is driven by supply economies of scale, platform business is driven by demand economies of scale; and where traditional pipeline business scales linearly, platform business scales exponentially (*Choudary et al. 2016*).

There are several examples of digital platforms: Airbnb, which mediates the rental of accommodation facilities by connecting hosts with guests, and Uber, which mediates transportation by connecting drivers with passengers, are a couple of the classics.

The main characteristics of digital platforms are that value creation is demand-driven and takes place in a network consisting of different types of users taking the roles as producers and consumers, and that it is the interaction between the users that determines the activities on the platform and enables value creation. On a digital platform, it is not about one player controlling value creation, but about value creation arising as a result of the interaction between users exchanging "something of value" via the digital platform, which provides tools and rules to make exchanges easy and mutually rewarding.

The *core interaction* is the single most important form of activity that takes place on a platform – the exchange of value that attracts most users to the platform in the first place. All digital platforms have a core interaction – and typically also support exchange of other types of value creating interactions (*Choudary et al. 2016*). Advantages of digital platforms are that activity is demand-driven and scales in pace with need.

A well-functioning digital platform depends on bringing value both to the users and to other stakeholders of the platform. To achieve this, setting up the right governance conditions for the

platform is crucial. Doing this is the responsibility of the so-called ecosystem driver[1]. A digital platform focuses on value creation within a specific business field. Digital platforms can complement each other, so that the individual platform's value creation will be part of a larger overall value creation.

New business concept scheme

Based on the actual state of SDI implementation and digitization trends as described in the background/literature review chapter above, this article presents a new business concept that extends the scope for how spatial data infrastructure (SDI) can be implemented with regard to the maintenance of geospatial data in general and of spatio-legal data in particular.

VGI-enabled digital SDI platform

The digital platform business model lends itself well to be the business model for spatial data infrastructure (SDI). The users of a digital SDI platform are *dataset authorities* protecting and taking care of datasets with geospatial data and *end-users* utilizing geospatial data to solve their task – plus *other types of users* that are involved in the dissemination and maintenance of the geospatial data. A digital SDI platform provides geospatial services, supporting the exchange of "something of value" between the users of the SDI, and thereby facilitates value creation for all users. In an environment where SDI is open for volunteered geographic information (VGI-enabled SDI), the digital platform approach opens new perspectives for how SDI can be developed for the benefit of both the users and for other stakeholders in the SDI.

The *core interaction* of a digital SDI platform handles the exchange of data packages with extracted information (e.g. geospatial data objects) from *dataset authorities* to *end-users*: dataset authorities publish information about available data sources; end-users search for and request information to be extracted from available data sources; and dataset authorities produce data packages that are sent to and consumed by end-users.

Core interactions can take place directly between *dataset authorities* and *end-users*. However, end-users will typically not have the time, the resources, or the competences to request and utilize the data packages offered by dataset authorities in a meaningful way to solve their task. Therefore, another type of user is appropriate: *application suppliers*, offering tools requesting and utilizing the data packages. As mentioned before, this approach is already in existence.

A VGI-enabled digital SDI platform also supports the *update interaction* that handles exchange of data packages containing update transactions with (maintained) data content from *end-users* to *dataset authorities*: end-users produce and upload update transactions with (maintained) data content and dataset authorities receive and consume update transactions that are used to update datasets.

Also *update interactions* can take place directly between *dataset authorities* and *end-users*. However, end-users will typically not have the time, the resources, the competences, or the standing to produce data packages with update transactions that satisfy the requirements set by dataset authorities. This calls for yet another type of user: data maintainers, offering data maintenance services producing data packages on behalf of the end-users to be uploaded and consumed by dataset authorities.

[1] Digital platform literature often uses the term "platform owner" for this player. In a government environment the term "platform driver" seems more appropriate, and that is the term used in this article.

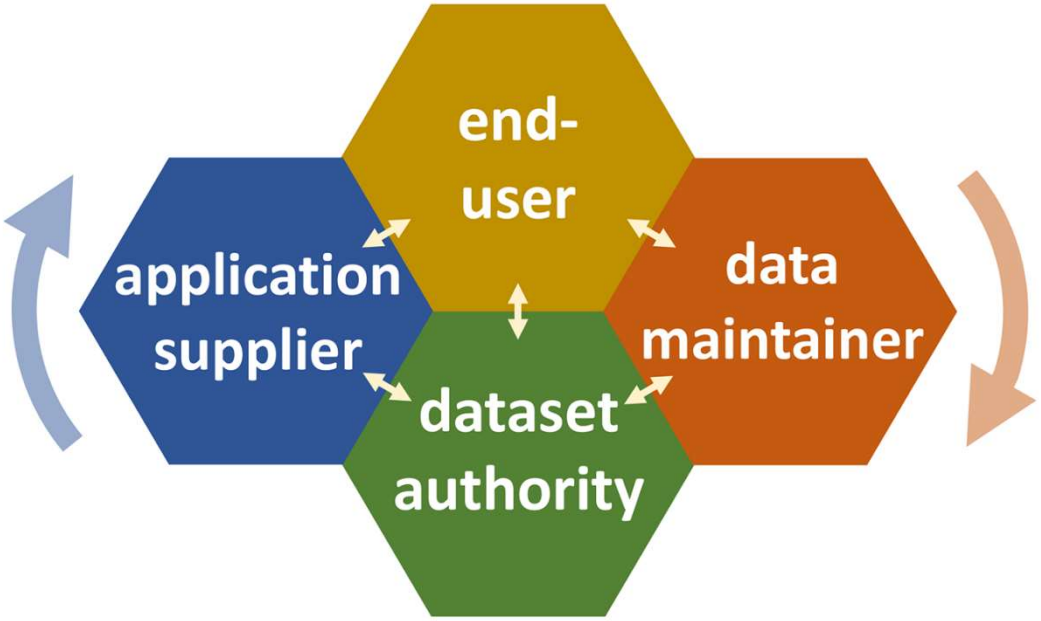

Figure 1: Business model for a VGI-enabled digital SDI platform.

Spatio-legal data and property rights

The VGI-enabled digital SDI platform described above is a general concept that apply to all types of geospatial data. The remainder of this article will focus on how this concept could influence processes regarding the maintenance of geospatial data that is used or created in an environment based on legislation –so-called 'spatio-legal data' (*Hvingel et al. 2014*) – and can help increase quality of and societal benefits from such data.

Land tenure is the relationship among people with respect to land and associated natural resources (water, trees, minerals, wildlife, etc.). Rules of tenure define how property rights in land are to be allocated within societies, they define how access is granted to rights to use, control, and transfer land, as well as associated responsibilities and restraints. Land tenure systems determine who can use what resources for how long, and under what conditions (*Munro-Faure et al. 2002*).

Secure property rights and efficient land registration institutions are a cornerstone of any modern economy (*Tuck and Zakout 2019*). Applying rules of tenure to real-world conditions requires knowledge about a multitude of real-world objects and phenomena. In a digital environment, such real-world objects and phenomena must be represented by geospatial data that is generally trusted as authoritative and fit for purpose. This is where 'spatio-legal data' comes in as critically important for securing property rights.

The traditional way of handling spatio-legal data is that it resides in registers where government authorities serve as custodians for specific types of data. In this role the authority handles all aspects of registration: the authority determines the rules associated with the register, and the authority takes care of establishing and maintaining the contents of the register, potentially with the participation of other authorities (e.g. a state authority with the participation of municipalities). The role of the end-users is solely to use the registers' data and possibly to make the responsible authorities aware of perceived quality problems in the data.

Advantages of the traditional approach are that registers are optimized for the purposes pursued by the custodian government authorities, and that all updates of registers' spatio-legal data are subject to direct regulatory control with the credibility inherited in this. Disadvantages of the traditional approach are that registers adhere to different principles and standards making interoperability challenging, that maintenance of spatio-legal data is based on budget appropriations without close relation to the external value creation, and that quality improvements that occur externally from the custodian government authority (e.g. in connection with the use of spatio-legal data in application projects) are not easily fed back to relevant registers.

The result of using the traditional approach is that registers with spatio-legal data are often challenged on quality, on approachability, and on interoperability, resulting in end-users having a hard time piecing together a complete and consistent picture that is fit for digital use.

Empirical evidence and practice review

One of the most important undertakings for a chartered land surveyor (in the following just referred to as 'land surveyor') is – on the basis of current rules – to ensure a fair handling of property rights in relation to both rights holders, third parties and society in general. Here, spatio-legal data is essential. How the handling of property rights is organized differs significantly from country to country. The following description is based on how it is organized in Denmark.

In the cadastral field, land surveyors act as trusted, private players on the edge of government. Based on government regulations and under professional responsibility, land surveyors carry out cases with associated regulatory consultations and data updating, and they bring these to a formal conclusion including the updating of government registers. With the data quality challenges mentioned above and with the opportunities offered by digitization, it is obvious to pursue the idea that land surveyors can play a similar role in maintaining and improving the quality of other spatio-legal data relevant for land tenure, and secure that relevant registers are updated. A few real-life examples will illustrate the challenges and the opportunities.

Example 1: Planning area boundaries adapt to cadastral changes

To ensure the credibility of legally applicable planning data, it is important that data is continuously adapted to the geographical registration basis – the cadastral map. The process guaranteeing this should therefore be linked to the cadastral case preparation process, where the land surveyor partly prepares documentation for cadastral changes in the cadastre as a result of subdivision, land transfer, etc. and partly makes a continuous improvement of the cadastral map in relation to technical changes, e.g. map rectification. These changes presuppose that the planning theme (and all other themes where the cadastral map is used as a registration basis) is adapted, which is a natural task for the land surveyor to undertake based on guidelines formulated by the responsible authority for affected themes.

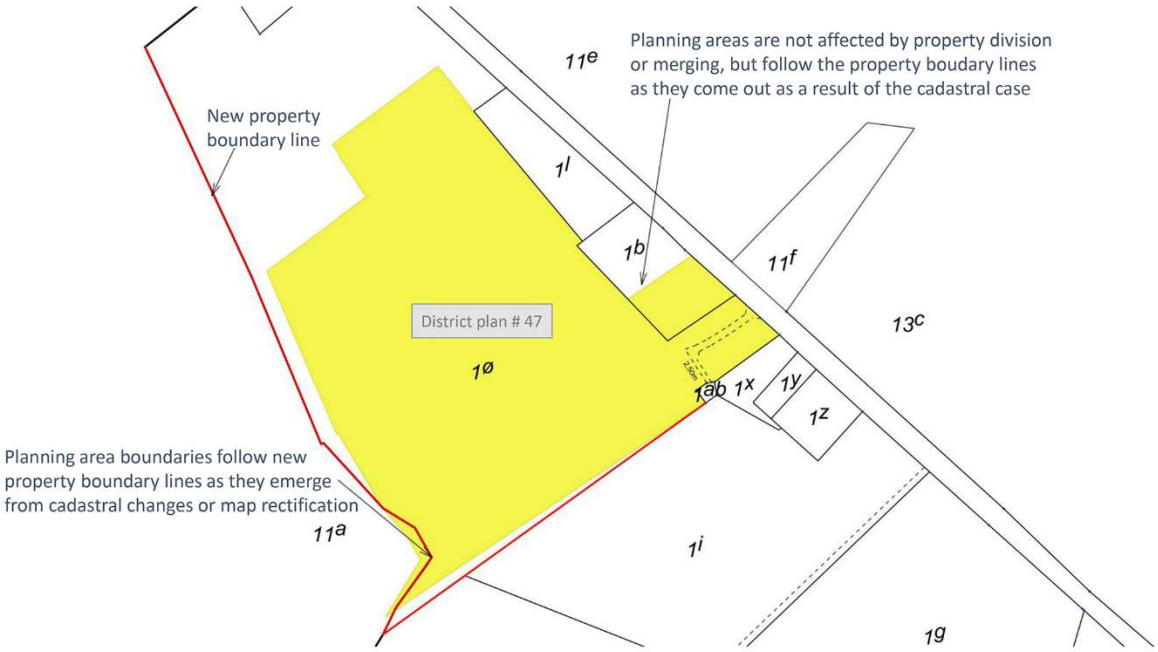

Figure 2: Planning area boundaries adapt to cadastral changes.

Example 2: Easement locations defined in form of coordinates

When registering easements comprising, for example, protection of pipelines, where a geographical location of the pipeline has been determined in the form of coordinates (e.g. in a GML file or associated with a land registry sketch), this data should be accepted as spatio-legal data. A digital use of geographically defined easement data can be included as spatio-legal data in relation to the preparation of easement declarations in connection with cadastral changes, for easement surveys in connection with local development plan preparation, etc.

Figure 3: Pipeline easement determined in form of coordinates.

Example 3: Easement registrations kept up to date

Easement information in the form of spatio-legal data should be included as an integral part of all real estate transactions, where, via geographical representation, the buyer is informed about registered bindings that apply to the property in question. This will allow for an ongoing improvement of the registration of easements in the land registry and thus ensure that older easements that are out of date are cancelled. The land surveyor and other private players who contribute to the sale of real estate can thereby contribute to ensuring easily accessible and reliable information about registered easements.

A role for land surveyors as illustrated in the examples above will ensure that spatio-legal data is quality improved and maintained on a demand-driven basis in close connection to events whose legal significance is highly dependent on the data. Although specific conditions differ significantly from country to country, it is the perception of the authors that similar challenges and opportunities exist in many countries. The question is how a model built on data maintenance approaches, as presented above, can work organizationally, legally, and financially. The remainder of this article presents a suggestion for this.

Findings

Based on the literature and practice review, this study suggests a VGI-enabled digital SDI platform for handling spatio-legal data (in the following referred to as 'digital SDI platform'), with the following characteristics:

- supports securing property rights, concrete case processing as well as analysis and planning tasks,
- is based on consistent legal requirements for data and associated maintenance processes,
- is well documented and supports temporality,
- supports demand-driven continuous data quality improvement,
- offers a common geographical reference across different types of spatio-legal data, and
- is easily accessible to authorities, citizens, and businesses.

The model operates with demand-driven maintenance of spatio-legal data in an environment directed by end-user demand rather than dataset authorities' budgets, where capacity is scaled flexibly rather than depending on dataset authorities' capacity, and where funding is linked to data value rather than subject to dataset authorities' appropriations.

The categories of users operating on the data maintenance part of the digital SDI platform consist of *dataset authorities*, *end-users*, and *data maintainers*. *End-users* utilize spatio-legal data as part of doing their business, and request data maintainers to perform tasks that include updating spatio-legal data; *data maintainers* operate with the approval of dataset authorities and provide update transactions to datasets controlled by dataset authorities.

Government control is maintained by establishing rules that data maintainers must comply with in order to be approved. Changes to spatio-legal data must be made through change cases that are traceable via metadata, and thereby ensure that the changes are well documented. This ensures that data can serve as an authoritative basis for issues concerning property rights. The fact that data maintainers operate with the approval of dataset authorities also addresses potential doubts about the credibility of the updates received. In this connection, it would be natural to require that data maintainers operate as independent businesses, are subject to professional liability, and are covered

by liability insurance. Land surveyors are obvious candidates to engage in the role as data maintainers on the digital SDI platform.

The users, together with other stakeholders (legislators, professional associations, NGOs, etc.), constitute the platform's ecosystem. In order for the digital SDI platform to handle spatio-legal data successfully, the ecosystem driver must take responsibility for the platform's business model and technology foundation, ensure that framework conditions and incentive structures are in place, and establish overall requirements and guidelines for the platform's users, quality management, change processes, documentation, traceability, etc.

The role as ecosystem driver must be rooted in a government authority. The role requires a mandate to prescribe cross-cutting coherence in data and processes, an appropriate division of activities between public and private players and a sustainable financing model. This is an overall authority role that cuts across the traditional division of government roles, and where sub-elements of the role today typically are scattered among several existing agencies in different ministries. It is a challenge not to be underestimated to establish this overall role with one competent authority.

The value of spatio-legal data is tightly linked to securing property rights. Therefore, the model operates with financing of quality improvement and maintenance of spatio-legal data tied to events where secure property rights are of utmost importance. These are events related to location, possession, protection, use, mortgaging, and taxation – for instance disagreement over property rights, sale of property, division of property, change of use of property, expropriation of property, physical planning of significance to property, land distribution, property assessment and payment of subsidies related to property. At such events, requirements should be introduced that relevant spatio-legal data be verified to be correct and, if necessary, updated. The end-user, who has a primary interest in the event, requests the data maintenance and is, as a general rule, also the one who finances the execution of the task.

Letting the financing follow the value, as described, changes the traditional way of incurring expenses related to the maintenance of spatio-legal data. Here it should be noted that part of the financing is thereby transferred from public to private players, e.g. to property owners. In some countries e.g. subdivision of property or sale of property are currently charged not only with cost incurred charges, but also with taxes on these events (subdivision fee or registration fee). Adjustment of such fees could be used to ensure the balance between public and private funding.

Discussion and Conclusions

The model described outlines a fundamentally different approach to division of activities, responsibilities, and financing between the players involved in improving quality and maintaining spatio-legal data. It is the view of the authors of this article that the model offers a resource-efficient approach to solving the task – a view that obviously needs to be verified as part of subsequent studies.

The biggest challenge in moving forward with the model, however, is probably that it represents a significant change from the way spatio-legal data is handled today. Implementing the model requires a strong authority to set the common management conditions and drive development, and a great deal of knowledge and digital maturity among dataset authorities and data maintainers. Are the competencies, the will, and the courage present to implement a model that to that extent means digital disruption in a conservative and tradition-bound area?

The model described is built on a generic core based on the concepts of VGI (volunteered geographic information), digital platforms, and SDI (spatial data infrastructure). In this article, the model is unfolded in relation to spatio-legal data and land surveyors. The model can be unfolded correspondingly in relation to other professional groups/data types. For example, it is conceivable that construction experts, who currently prepare condition reports in connection with sale of property, will be given a role in improving the quality and maintenance of a government building and dwelling register, or it is conceivable that companies, who currently prepare environmental impact assessments in connection with building and construction projects, will be given a role in improving the quality and maintaining environmental data. The possibilities are many. The assessment of the authors is that the societal benefits that can be achieved by improving spatio-legal data make the role of land surveyors in relation to the work with property-related data a good place to start.

References

Alstyne, Marshall W. Van; Parker, Geoffrey G.; & Choudary, Sangeet Paul (2016). Pipelines, Platforms, and the New Rules of Strategy. Harvard Business Review https://hbr.org/2016/04/pipelines-platforms-and-the-new-rules-of-strategy

Choudary, S., Alstyne, M.W., & Parker, G. (2016). Platform Revolution: How Networked Markets Are Transforming the Economy--and How to Make Them Work for You.

Danish Government (2012). Good basic data for everyone – a driver for growth and efficiency. https://en.digst.dk/media/14139/grunddata_uk_web_05102012_publication.pdf

European Parliament and Council (2007). Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE). http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX%3A32007L0002%3AEN%3ANOT

European Parliament and Council (2019). Directive (EU) 2019/1024 of the European Parliament and of the Council of 20 June 2019 on open data and the re-use of public sector information. http://data.europa.eu/eli/dir/2019/1024/oj

Flanagin, Andrew J. and Metzger, Miriam J. (2008). The credibility of volunteered geographic information. GeoJournal 72:137–148. https://www.researchgate.net/publication/226851393_The_Credibility_of_Volunteered_Geographic_Information

Hansen, Thorben and Hollænder, Jens (2004). The Map Supply – A New Way of Providing a National Geodata Infrastructure. FIG Working Week 2004. http://fig.net/resources/proceedings/fig_proceedings/athens/papers/ts10/TS10_2_Hansen_Hollaender.pdf

Hansen, Thorben (2018). Digital technology transforming SDI. https://geoadvice.dk/digital-technology-transforming-spatial-data-infrastructure/

Hvingel, Line; Baaner, Lasse and Schrøder, Lise (2014). Mature e-Government based on spatial data – legal implications. International Journal of Spatial Data Infrastructures Research, 2014, Vol.9, 131-149 https://www.researchgate.net/publication/311908988_Mature_e-Government_based_on_spatial_data_-legal_implications

Munro-Faure, Paul; Groppo, Paolo; Hererra, Adriana; Lindsay, Jonathan; Mathieu, Paul and Palmer, David (2002). FAO Land Tenure Studies 3: Land tenure and rural development. http://www.fao.org/3/a-y4307e.pdf

Overgaard, Bo and Hansen, Thorben (2008). The Spatial Information Infrastructure as Part of the Information Infrastructure. Creating Spatial Information Infrastructures: Towards the Spatial Semantic Web by Peter van Oosterom (Editor), Sisi Zlatanova (Editor), 165-176

PwC (2017). The impact of the open geographical data - follow up study. http://sdfe.dk/media/2917052/20170317-the-impact-of-the-open-geographical-data-management-summary-version-13-pwc-qrvkvdr.pdf

Tuck, Laura and Zakout, Wael (2019). 7 reasons for land and property rights to be at the top of the global agenda. https://blogs.worldbank.org/voices/7-reasons-land-and-property-rights-be-top-global-agenda

UK Cabinet Office (2012). Open Data White Paper - Unleashing the Potential. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/78947/Open-Data.doc

US President (1994). US Executive Order 12906 – Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure. Federal Register / Vol. 59, No. 71. https://www.archives.gov/files/federal-register/executive-orders/pdf/12906.pdf

About the article

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Bent Hulegaard Jensen, M.Sc. at Geopartner, Chartered Land Surveyors a/s and associate professor with affiliation to Aalborg University (land surveyor education). Bent has – both as an affiliate to Aalborg University and as a chartered land surveyor – worked with geodata in relation to especially the property data area and has been involved in various development and implementation projects.