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Developing Multi-Layer Information Infrastructures: Advancing Social Innovation through Public–Private Governance

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Information infrastructures of businesses and government are increasingly interwoven. The development of these information infrastructures often has a technological focus and the concurrent social innovation is ill understood. To address this gap, we study public–private information infrastructure developments at three layers over a prolonged period of time. Stakeholders have to alter existing social practices to realize the potential of information infrastructures. New social practices need to be developed and sustaining innovations requires new governance mechanisms.

Keywords information infrastructures; social innovation; public–private collaboration; governance; e-government; transformation

1. INTRODUCTION

Social innovations encompass "changes in the cultural, normative or regulative structures of the society which enhance its collective power resources and improve its economic and social performance" (Heiskala, 2007, p. 74). Moulaert, Martinelli, Swyngedouw, and González (2005) argue that social innovation fills a void that is left by governments that are retreating. Especially in times like the current economic crisis, government organizations are looking for ways to do more with fewer resources. To realize this, they are looking for innovative ways to collaborate with businesses and have initiated innovation processes, but are often struggling to ensure progress.

Social innovation is still a broad and ill-understood concept (Rüede & Lurtz, 2012). One of the main challenges of social innovations of infrastructures is to get to fruitful and large-scale realization (Moulaert et al., 2005). Although there is a lot of work about social innovation, there is scant attention given to social innovation in large-scale public–private innovations. Often social innovation literature focuses on local initiatives, e.g., by volunteers, neighbors, and patients (Rüede & Lurtz, 2012), whereas, the idiosyncratic nature of public and private organization introduces unique challenges related to the different objectives and warranting public value in collaborations with the private sector (Jørgensen & Bozeman, 2007).

In the present study, we investigate the development of public–private information infrastructures. Information infrastructures are considered to be a new stage of information and communication technologies (ICT) innovations, the development and study of which comprises both the technological components as well as the social aspects (Tilson, Lyytinen, & Sørensen, 2010). The emergence of these information infrastructures comprises technological characteristics, capabilities, and the interactions and negotiations between actors involved in the development (Tilson et al., 2010; Constantinides, 2012). Social factors affect the development, adoption, change, operations, and stability of information infrastructures. Given the high stakeholder complexity that comes with public–private collaborations, the role of social factors is even bigger.

The development trajectories in which information infrastructures are being designed and implemented often have a technological focus, with a central role for the technical artifact. Despite the acknowledgement that social factors play an important role in the technical innovation, the interrelated development of new social practices that concurrently takes place are understudied. Hence, the social innovation taking place next to the technological innovation is ill understood. To address this gap, we study three public–private information infrastructure developments and focus on the innovation in the social practices. The key questions that we address in this article are: In the development of sociotechnical information infrastructures, what is the social innovation taking place, and what is its relationship to the technological innovation that defines these information infrastructures?

We address this by studying the development of three interrelated information infrastructures that support public–private collaborations. These developments also alter the social practices that currently define the collaborations. The three development projects occur at multiple layers (international, national, and communal) and in all three both technological and social aspects play a role. Whereas, there is some understanding

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of how the technical developments mutually influence each other, the interdependence between the social innovations that also takes place in these three projects, is largely unknown. By studying these social innovations as the focal point of our study, but in relationship to the technological developments, we aim to understand the social innovation that is taking place within and among these layers and within their technological context.

Thus, we apply the concept of social innovation to large-scale sociotechnical developments, occurring in a complex public–private setting and with immediate impact on the social practices of a great number of parties. Thereby, we also contribute to social innovation literature, which is often focused on innovations on a smaller scale, often at a local level, via (communities of) individuals. We followed the developments in our multi-layer case study over a period of 18 months and observed development from technology-driven projects to a complete transformation of the infrastructure.

The article is structured as follows; first we describe the background of the key concepts in this article. In section 3, we describe the research approach. In section 4, the empirical material is presented and analyzed to assess in what way a changing social practice among the diverse set of stakeholders affects the innovation process of setting up the information infrastructures. In section 5, we discuss the findings in terms of the tools of governance that actors must develop to be able to cope with these changing practices. We then discuss the implications for the key concepts and end with conclusions.

2. THEORETICAL BACKGROUND

Information infrastructures are considered to be sociotechnical artifacts (Hanseth & Lyytinen, 2010; Tilson et al., 2010). Often, literature emphasises the technological aspects and the effects that social aspects have on them. Our study focuses on the social innovations that take place in the context of information infrastructure development. In this section, we introduce the concept of social innovations, the developments of public–private information infrastructures, and conclude with describing the how social innovation is an integral (albeit sometimes implicit) part of setting up public–private information infrastructures.

2.1. Social Innovation

At its heart, social innovation refers to innovation as a social phenomenon. As such it can be seen as a response to a technological bias and technocratic approaches to innovation (Moulaert et al., 2005). Social innovation concepts are used in studies on a variety of topics, including innovation in public and business services, social entrepreneurship, open source innovation, complex adaptive systems, diffusion of innovations, collaborative approaches, and stakeholder involvement (Moulaert et al., 2005). A key element in most work on social innovation is the interaction between people, and their organization in communities. Many social innovations covered in literature are also grassroots-level projects that address challenges in society and improve peoples' lives (Moulaert et al., 2005; Rüede & Lurtz, 2012). As the social innovation concept is used in various ways and contexts, Rüede and Lurtz (2012) attempted to structure this by identifying the following forms that social innovations can take:

- Doing something good in/for society;
- Changing social practices and/or structure;
- Contribute to urban and community development;
- Reorganize work processes.

Of these four types of social innovation, the social innovations in our study are primarily related to the second. This category covers changes in social practices and social structures, explicitly also as part of socio-technological innovations. This category can include sociotechnical and business innovations, as well as societal innovation (Howaldt & Schwartz, 2010). This type of social innovation can be defined as "new ways of doing things, especially new organizational devices, new regulations, new living arrangements, that change the direction of social change, attain goals better than older practices, become institutionalized and prove to be worth imitating" (Zapf, 1991 as cited in Ruëde & Lurtz, 2012, p. 14). An institution here can be defined as

> a set of laws, regulations, organizations, . . . formal and informal socialization mechanisms and processes that have attained a certain stability and/or regularity over time in the form of habits, laws and rules of behavior and sanctioning, as well as organizations as institutionalized multimember agents (Moulaert et al., 2005, p. 1976).

Befitting this definition, we see governance as the defining and allocating of actions and decisions that ensure a form of collaboration that cannot be externally imposed (Stoker, 1998). Social innovation can be found in (1) an innovation product (*what*), (2) the actors making it (*who*), and (3) the process (*how*; Rüede & Lurtz, 2012). Moulaert et al. (2005) provide a further specification of the latter in the sense that social innovation can refer to a certain type of innovation process, but also to innovations *in* processes.

2.2. Information Infrastructures and Public–Private Collaboration

Under a variety of terms, public–private collaboration has been put forward as a way for governments to organize public action more effectively and efficiently (e.g., Dunleavy, Margetts, Bastow, & Tinkler, 2006; Fountain, 2001; Milward, Provan, Fish, Isett, & Huang, 2010; Pollitt & Bouckaert, 2004; Salamon, 2002; Stoker, 2006). Cooperation between public and private organizations has a long history. Already back in the 1970s, and again in the 1990s, public–private partnerships were established to strike a balance between the entrepreneurial spirit

and public interest considerations (Linder, 1999). Cooperation should ideally bring the best of government (e.g., public values) and private (e.g., efficiency) organizations (Pongsiri, 2003; Rosenau, 1999). A major driver for such collaboration is dependence on resources or competencies of other organizations (cf., Selsky & Parker, 2005). However, cooperation with other organizations introduces new sets of stakeholders, with potentially different interests, goals, procedures, and relations.

As interactions between organizations are to a large extent facilitated by ICTs, public–private collaborations exist in a heterogeneous landscape of actors, physical and technical systems, with repeated and enduring exchange relationships, both at the organizational level and at the level of information systems and data (cf., Podolny & Page, 1998; Tilson et al., 2010). Public–private collaborations have been used for funding and operating infrastructures in the past (Grimsey & Lewis, 2007). The public organizations must have the capacity to govern the collaboration, yet has limited means for doing so. Amongst the lessons from research is that such public–private partnerships often bring complex governance arrangements to distribute costs, benefits, share risks, and distribute responsibilities and accountability. Especially in these areas, public–private collaboration introduces multiple—potentially conflicting—interests, goals, and values (e.g., Flinders, 2005; Rosenau, 1999).

We focus on the development of information infrastructures that support the highly repetitive information exchange between public and private organizations. These public, private, and shared information systems together constitute the information infrastructure, which is owned, operated, and maintained by various organizations, both from government and the business community. Many stakeholders are involved in developing the complex infrastructure, which makes this a socio-technical development endeavor characterized by emergence, evolution, self-organization, and openness (Janssen, Chun, & Gil-Garcia, 2009). These many aspects complicate social innovation, as it requires radical change trajectories resulting in permanent organizational change (Irani, Elliman, & Jackson, 2007; Weerakkody & Dhillon, 2008). Compared to "traditional" inter-organizational information systems, information infrastructures are characterized by the involvement of many actors with different requirements, that are using different technologies, and having varying degrees of maturity; hence a combined social and technical complexity (Hanseth & Lyytinen, 2010; Northrop et al., 2006; Tilson et al., 2010). There is not one party with a complete overview of all systems, functionality, and uses, nor a party with control over this diversity. In the innovation process this can lead to unexpected and un-designed interactions between systems and actors (cf., Hanseth & Lyytinen, 2010). As a result, it will have to be decentralized and the shared components of the infrastructure as well as the governance thereof have to be collaboratively developed by the stakeholders (Klievink, Janssen, & Tan, 2012). Previous studies on public sector innovations have found many social factors that play a role (e.g., El-Haddadeh, Weerakkody, & Al-Shafi, 2013). These factors follow from the fact that changes in public governance and specifically public–private collaboration are also a change in the structures, processes, and practices that shape the traditional ways of working. This is because public–private collaboration goes beyond mere collaboration but entails an entirely different way of working and of organizing activities. Collaborations have to deal with challenges like the sharing of investment and cost, distributing roles and responsibilities, setting-up contracts, etc. (Pongsiri, 2003). Both business and government systems are connected to each other, owned and operated by a diverse set of public and private actors. The technical complexities of implementing these platforms is compounded by the number of stakeholders affected by and involved in the decision making process.

2.3. The Social Innovations of Public–Private Information Infrastructures

Public–private collaboration introduces new complexity and new uncertainties for the parties involved, due to increased interdependence and potential vulnerability (Hart & Saunders, 1997; Kumar & Van Dissel, 1996). Despite that the use of information infrastructures to support and enable these collaborations are rightfully called socio-technical innovations, current literature emphasizes the technological innovation and how social factors affect those innovations. However, the dependencies between the actors involved in public–private information infrastructures resemble a network structure, in which a multitude of interdependent actors exist (De Bruijn & Ten Heuvelhof, 2008). Often the organizational goals of the (autonomous) parties are not in line with the goals of the chain as a whole. However, the performance of the network depends on the individual organizations. Therefore, the stakeholders are often working with each other within a formalized relationship, which is the area of governance. In governance the allocation of decision-making is an important component (Peterson, 2004). As the improvement of operations of actors is often a key driver for the development of (new) information systems (Chwelos, Benbasat, & Dexter, 2001), this often also implies innovations in products, processes, and organizations. The changes and developments in large-scale information infrastructures also have implications for the processes and workflow that people work with on a daily basis. Hence, we argue that to understand the development of public–private information infrastructures it is not sufficient to understand the technological innovation in its social context, but that the social innovations that co-occur with these technological innovations, themselves need to be understood as well. That is what this study seeks to address.

Following the conceptualization of social innovations earlier in this section, the typical practices that are the object of social innovation are the changing institutional and governance structures. This is especially important for innovations in public–private information infrastructures, as the innovation process' primary objective is still often developing an

information infrastructure as a technological artifact. From the social innovation perspective, the changes in social practices, institutionalized in a governance structure, are also viewed as a major outcome that the innovation could or should lead to. Following this, social innovations can be seen as processes that restructure the relationships between actors and introduce new social practices, specifically new modes of collaborations. These new forms of collaboration are required to establish middle ground between the value for society and government, and the various, diverse, business communities that have stakes in the information infrastructures.

3. CASE STUDY BACKGROUND AND RESEARCH APPROACH

In the domain of international trade, various initiatives have been taken to develop information infrastructures that make business data available digitally and share them instantaneously to public and private parties that are eligible to viewing the data. This development is rooted in a widely perceived need to enhance the sharing of information between the wide variety of actors involved in international trade, including traders, logistic service providers, information brokers, and government agencies concerned with many tasks including supervision and risk assessment. Complicated relationships between those parties and complex supply chains hinder the timely availability of accurate data and have put additional challenges to managing information in international supply chains. The information infrastructures comprise both public and private sector actors and are aimed to enhance efficiency and security, in the interests of the businesses involved in trade, in logistics, and in the interests of governments and society in general.

In this article, three information infrastructures development projects are studied. These developments take place at multiple layers:

1. *An international information infrastructure*, crossing borders and legal systems. Research and development by an international 26-party consortium of companies involved in international trade, IT solution providers, government authorities and research institutes. This information infrastructure covers international container supply chains over sea and action research was done in six international trade lanes between Asia, Africa, Europe, and the United States.
2. A *national information infrastructure* in the Netherlands, aimed to cover all logistics-related information flows in the country. Parties primary involved in the initiation and development of this project are business associations (representing e.g., logistics companies, shippers, air cargo industry, terminal operators, and brokers), port community systems, port authorities, government organizations, and the main ports Rotterdam and Schiphol.
3. A *trade-community system* for horticultural products. This type of information infrastructures is limited to the actors related to the product type, but may cross country boundaries. The development project under study was initiated by a cooperation of 5,000 businesses in the industry, supported by the government and research institutes. The information infrastructure aims to connect the sector by digital (logistical) information to enhance collaboration and (re)use of information. The focus is on electronic interconnectivity.

The projects were set up independently, but the information infrastructures are interrelated, as data and functionality that are a product of one, can also be a component of another. Furthermore, they partially cover similar parties and information flows. We focused on businesses involved in trade via the Port of Rotterdam, the largest port in Europe with 430 million tons of cargo annually. Just in terms of containers, its 11 million twenty-foot-equivalent unit (TEU) a year in containers make it also the biggest container port in Europe. The trade-specific infrastructure will, for certain parts of the supply chain, be a part of the international infrastructure, and simultaneously be part of one or multiple national infrastructures. In a similar vein, the international information infrastructure can be realized by joining up various national infrastructures. We take these three projects together as one case, although in some respects they could be seen as three cases.

3.1. The Social Innovation Challenge in Information Infrastructure Development

There is no central control over the initiatives, no single government organization or layer has jurisdiction over the complete international supply chain, and the wide variety of business parties has diverse, sometimes conflicting interests. Even within single infrastructures or layers, the need for gathering, sharing, and combining information from various sources requires that stakeholders having diverse interests collaborate. Business systems and digital government infrastructures have to be connected to each other, although they are owned and operated by a diverse set of public and private actors. The technical complexities of implementing these platforms are compounded by the number of stakeholders affected by and involved in the decision making process. For such a platform to work in the dynamic context of international trade and logistics, collaboration is required between the many different stakeholders. Especially the data that are of mixed public and private origin presents specific challenges (Klievink et al., 2012). The combination of using private and public data is essential for developing new functionality that creates economic incentives. However, the data are also commercially sensitive (e.g., no trader wants to reveal the prices paid), hence, actors are reluctant to share information.

3.2. Research Approach

In our role as a participant and observer in the research and development trajectories of all three information infrastructures,

we had the chance to analyze these developments. Whereas, much of the efforts and discussions in the projects were focused on the technical innovation (e.g., creating interfaces, setting up the infrastructure), we focused on assessing the changes in social practices that were related to these projects. We looked for new organizational and collaboration arrangements (cf., Zapf, 1991) that either follow from the development of the information infrastructures, that develop simultaneously or that had to be developed to further advance the (use of the) information infrastructures. Although profit-seeking innovations are not always included in the social innovation concept, we argue that the aim of the innovations in the case in this article is not to innovate for seeking profit, but to fundamentally change the practices of collaboration between public and private sector actors.

We followed the development of the information infrastructures during 18 months, between 2011 and the beginning of 2013. In April 2013, a covenant was signed between government and the business community in the Netherlands. For the research, we conducted 26 interviews in total (individual and group) with people involved in either one of these infrastructures. The semi-structured interviews lasted between one and two hours. Each of the layers was subject of interview at least at four points in time. Furthermore, between March 2012 and April 2013, we observed the bi-monthly meetings of an advisory board that served as a feedback-forum for the stakeholders involved in innovation project. As we aimed at a descriptive and exploratory analysis of social innovations related to information infrastructure development, a case study approach is used (Yin, 2009). By viewing the three elements as one case study, we could use the interviews and observations from all three projects for our assessment of the social practices surrounding the case as well as the changes in them.

4. ANALYSIS: SOCIAL INNOVATION IN INFORMATION INFRASTRUCTURE DEVELOPMENT

Often, information infrastructures that are being developed enable new functionalities by bringing together multiple sources of data, systems, and functions. This is also the case in the information infrastructures under study. In our case, data are often brought together to enable functionality related to legal obligations of the business community towards government. For example, customs can consider goods to have been exported based on the combination of the export declaration by the exporter, the logistics information of a logistics service provider (e.g., in which container goods were stuffed), information from the container terminal and shipping line (e.g., on which ship the container was put), and the port authority (which ships have left the port and thus, the country). When aiming to implement such functionality, often the existing procedures and information flows are automated. However, especially when both public and private sector actors are involved, these information infrastructures also enable innovations that add more value, for example by enabling governments to re-use data from the businesses (potentially added to or as a substitute for official declarations), or by making other smart combinations of data to provide new services. These potential innovations are not a challenge for the technology per se, but they do enable different social practices as well, especially in the way that inspection agencies and trading businesses interact with each other. Furthermore, new value adding functionalities also creates uneasiness by the parties involved, for example with respect to the quality of information that others provide, or with respect to what other do with their data. This requires sets of agreements and other instruments governing the data exchange, functionality and the interdependence these present to the stakeholders that are both provider and user of data simultaneously.

Apart from the development of the information infrastructure itself, in two respects a social innovation also takes place. First, as pointed out above, the public–private information infrastructures enable new social practices, primarily related to the business-government interaction. Following the literature on social innovation, this can be considered social innovation as an innovation product. Second, because the development of the information infrastructures are able to bring profound changes to way parties work and as this may lead to increased (perceived) vulnerability of those actors, the development process itself must be combined with or even preceded (as we find in our study) by a process in which these issues are addressed. Following the literature, this can be considered social innovation as a process.

4.1. The Key Actors

Many actors are involved in international trade. In the projects, the following key stakeholder groups were involved.

- Port community systems; providers of systems where parties operating in main port environments can exchange information, both for supporting logistics and port processes and for the exchange of information with government agencies.
- Port authorities; responsible for the port. In many cases the port authority is a (major) shareholder of the port community systems.
- Customs and other government organizations, especially those concerned with the supervision of international trade, such as product and food safety inspection agencies.
- Logistics parties, such as freight forwarders, primarily those operating at the global level. Smaller logistics operators (e.g., transport companies) are represented through representatives (e.g., industry associations). Other parties include shipping lines and terminal operators in the ports.
- Shippers, which are the buyers and sellers shipping the goods that drive international supply chains. They form are a fragmented community, in the national

information infrastructure they were involved through an industry association, in the trade community system by a cooperation, and in the international project through the freight forwarders they employ to manage their supply chains.

For each of the information infrastructures, we describe the innovation process highlighting the implications for the social innovation as a product and/or a process.

4.2. The International Information Infrastructure

The development of the international trade information infrastructure was part of a large project, which addressed it as primarily a technical development. In this process, a series of non-technical issues came up: actors feared losing ground, the business requirement of government incentives in the form of the information infrastructure leading to new government supervision approaches, the limits that existing legal frameworks put on the options for such new approaches, and the incompatibility between what the information infrastructure required of the parties and the current practices and cultures within those organizations.

At first, these issues were addressed as problems that could be solved with technical solutions, including an enhanced data security framework and the introduction of role-based access, based on the roles that currently exist in the supply chains. There was a separate project activity focusing on the changing business-government interactions. However, this activity was positioned in the last of the (three year) project. That activity's emphasis was on the need to establish consensus between organizations, to establish new business-government interaction protocols, and propositions for changes in legislation (although that will take a long time, given the international scale). The lesson from that activity was that only through focusing on the social innovation also taking place, it became clear that issues had to be addressed by setting up new forms of collaborations between actors, by new legal practices, and a re-structuring of some parts of the supply chain.

We also found that the emergence of national information infrastructures that could be connected to each other would greatly increase the take-up of the international infrastructure. However, to make that work, the various national information infrastructures have to adhere to the same standards and agreements, further emphasizing the need for a consensus-building process at a very large scale in terms of diversity and number of actors involved.

4.3. The National Information Infrastructure

As part of an innovation strategy for the logistics sector, the Dutch government initiated a debate on setting up a national platform, not limited to specific ports, like port community systems often are. Similar to the international information infrastructure (which was being set-up at the same time), this was addressed as a technical challenge, primarily related to interoperability. However, existing port community systems, local initiatives from business communities, and government organizations all sought to see their interests put first in the development of this information infrastructure. Even the selection of standards and decisions on interoperability were more related to how parties thought they could lead to changing practices to their advantage than that they were about the technical design. This was recognized at the beginning of the project and the parties agreed that the issues needed to be addressed in the institutional design of a governance structure before any next steps could be taken in the technical development. The issues that needed to be covered by the governance structure include: Which data were going to be used, from whom, who has access, which functionalities are permissible, what the funding structure looks like, and which (especially industry-specific) standards were going to be used or supported.

To realize this governance structure as an innovation, a governance advisory committee was set up specifically for working out the governance arrangements. Given the presence of existing platforms, the decisions made in this advisory committee impact the technical solution. The discussions in the governance board took over a year to complete. First, the platform providers were involved, and most of these actors had no desire to sacrifice their own platforms and services for the greater good. Government actors considered this a business initiative, and did not want to interfere in the process. This forced the other business to shape the information exchange infrastructure. Their fear was that the government would mandate the use of this infrastructure, forcing all businesses involved in trade in this country to exchange information via its providers. Therefore, the fragmented business community (shippers, logistics parties, transport companies, etc., through the business federations) had to organize joint action to steer this debate in a direction that was acceptable to all parties, and to not let the existing platform providers structure it in a way that would preserve their own role. Ultimately, in April 2013, a covenant was signed between the stakeholders, in which the information infrastructure was formed as a cooperation, finalizing the (first stage of the) social innovation process. Only after that has finished, any real steps in the technical development could be made. The social innovation thus had to precede a technological innovation.

4.4. The Trade Community Information Infrastructure

The issues in the trade community infrastructure were similar to those described above but followed a different path. In this case, much of the discussion was between organizations representing the various industries, and not between competitors within a branch. As a consequence, the current infrastructure is aimed at providing low-level technical interconnectivity, based on electronic transport orders. The facility is also limited to businesses operating in the horticulture industry, although similar requirements exist in other (agriculture) branches. Different

to the national infrastructure, the basic technical facilities were put in place first and the social innovations (both as outcome and process) commenced thereafter. Only now, parties are starting to deal with the challenge of how to create added value functionalities and thinking of the requirements for opening-up the infrastructure to others. In 2013, a new legal entity was created to institutionalize the collaboration in order to further bring the technical infrastructure to fruition. However, the relationship between these types of trade community infrastructures and the national information infrastructure has long been a key topic for the actors involved in these projects. Multiple trade infrastructures combined would create the national infrastructure, but how their data and functionality would be integrated, as well as what the funding or compensation structure would look like, are issues that need to be resolved. The outcome was that these trade community initiatives got a formal role in the national information infrastructure.

4.5. The Results of the Social Innovation Trajectories

Comparing the events on the three layers show that similar activities happen at the same time, with roughly the same types of stakeholders, but are all independent projects. None of these projects currently develop specific tools to ensure that new practices and institutions are systematically assessed and treated as an innovation process that is related to but independent from the technological innovation. Especially parties that thought to gain from the technical infrastructures had no desire to acknowledge the interdependence with the other projects, which requires the infrastructure to be open, which is one of the key factors giving way to the social innovations required.

Still, in all three the innovation projects the parties found that they needed to establish new ways of intensified collaboration before the information infrastructure could work. This should help in joining-up the developments. In fact, the collaboration is so complex, that it would be very hard to organize that purely at the international level. Therefore, transforming the ways in which specific trade communities work and exchange data can enable national information infrastructures that join-up multiple of these more localized community information infrastructures and national digital government infrastructures. Next, through collaborations of multiple of these national information infrastructures, an international infrastructure can be created. This is necessary as localized infrastructures have the contacts and relationships with all the various businesses that international infrastructures have no tools to build. Furthermore, innovations in the interactions between the businesses and government are often highly related to a country-specific approach to supervision, as well as to the capabilities and mindset of public servants in that country. Innovations in the practices of public–private collaboration are more feasible at the national or local level than they are at the international level.

The key in making the innovation work on a large scale are the governance practices; these new social practices have to be embedded in existing or new institutional arrangements. The governance of data sharing, especially where public–private boundaries are crossed, is a key challenge in all infrastructures. Data ownership remains with the initial owner resulting in complicated situations, for example that some data is required to create services for the whole community, but then can also be used for commercial services. The infrastructure has to provide an authorization structure; the data provider may determine who is eligible to see the data, and can track who used the data.

The most specific outcome of the social part of the innovation process is the governance board in the national infrastructure layer. This board was important to decide on issues like the source of data, how they could be used, and the funding structure. The information is of vital importance for all parties involved, especially in the struggle between community and business use of the data in value added functionality. Therefore, in the governance advisory committee, it was decided that databases had to be part of the core of the infrastructure. In that design, the infrastructure contains databases, authorization, single sign-on and translation facilities. The infrastructure is thus an ICT infrastructure, where the databases of the existing infrastructures and newly developed trade community are connected to each other and to government databases. The functionality is separated from the other parts of the infrastructure. The governance arrangement focused on determining which parts need a governance or decision-making body and how these parts will be governed.

5. FINDINGS AND CONCLUSIONS: SHAPING COLLABORATION PRACTICES AND GOVERNANCE

The social innovation processes in all initiatives led to some sort of governance arrangement. Institutionalization took place in a collaboration covenant for the national infrastructure, and in a newly enacted legal entity for the trade community infrastructure. In the international infrastructure initiative, the main outcome is a change in the ways that parties involved in supply chains exchange information. The IT solution providers developed new ways of opening up data sources, and logistics companies and traders found ways to make data sharing work to enhance their operations at the supply chain level. The impact on the practices in government organizations was smaller, as they are bound by a strict legal framework that is hard to change, and at least takes a long time to do so. The outcome of social innovation process here were consensus building workshops, a policy agenda article and a new protocol for business-government interactions in international trade. Ultimately, the changes in the interactions between business and government will be essential for creating a business rationale for adopting the IT platforms that jointly form the international infrastructure. These changes are very much related to government's supervision approach, which has major implications on the legal framework, the practices and workings of the government organizations as well as the capabilities and culture of people working in those organizations.

From the case it is evident that numerous questions regarding the new social practices have to be answered before the information infrastructures can be further developed in a way that are acceptable to all actors. This includes questions like who will be involved, which data to share, which data actors need or want, which functionality is permissible or desirable, who may offer this, etc.

Much of the process had a "turkey-at-dinner" atmosphere; primarily logistics parties and platform providers had no desire to sacrifice their own platforms and services for the greater good. Therefore, the process was not progressing for over a year. A breakthrough was only there when the beginning and end of the chain (those with an interest in the goods) were introduced. This shows that the changes in the practices of people and organizations is a separate social innovation in the form of a process that actors need to go through to shape a setting in which the information infrastructure can be further developed, both institutionally and technically. When looking at the innovation process, it shows this was barely about the content and design of the infrastructure. This can be well explained using social innovation perspective, as the social innovation process needs to be finalized first, before the technical development can even work. That is why a governance arrangement—as an outcome of the social innovation process—is a prerequisite (i.e., it needs to be clear) before the debate can actually shift to the content of how the technical development can take place.

In our case covering large-scale innovations aimed at having a big impact, the technical innovation process encountered challenges that can only be addressed if the parties have laid out the basis for new ways of working. Furthermore, external disturbances can play a big role, like parallel developments that heavily affected the positions of the actors that play a role in the social innovation process. Finally, it is important to decide which parties are parts of the social innovation process, and how this is arranged. If the social innovation process is not open to key stakeholders, either the social practice does not change due to the limited diversity of the stakeholders involved, or the new social practices are not adopted by parties that need to adopt it to make the innovation work.

This also extends to the institutionalization of the governance the information infrastructures. It is important to get clear lines demarcating responsibilities, ownership, functionalities, revenue streams, etc., and allocate them in an institutional structure that accompanies the technical development. Important issues are to identify which parts are considered core infrastructure and services, and whether which components thereof are governed by the government, a neutral provider, a public–private collaboration, a business community system, or are left to the market. These issues are part of a separate process comprising of and affecting social aspects and interactions.

In conclusion of the empirical part of the study we argue that to be successful public–private information infrastructures have to be developed through a collaborative innovation approach, as actors have to give up control some over their data and systems to realize mutual benefits, supported by governance mechanisms making this possible. This supports a changing practice of collaboration in networks instead of in dyadic or principal-agent relationships to jointly come to a configuration that works for all stakeholders. Getting commitment and the resources that the parties need to provide to the project is very important. The entire setting in which actors operate may change because of a social innovation. Existing capacities that actors have may not be fit to use in the new practices and forms of cooperation that result from the social innovation. Organizations need to adapt and re-configure their competences along with the social innovation process. On top of existing technical and transformation capabilities, this requires organizations to develop advanced social and collaborative capabilities, to be able to realize new modes of public governance through maximizing the effectiveness of public–private information infrastructures.

6. DISCUSSION AND SUGGESTIONS FOR FURTHER RESEARCH

The social innovation perspective shows the dependency of technical innovation processes on the changes in the cultural, normative, and regulative structures: The social innovations. Whereas, literature on information infrastructures emphasizes the socio-technical nature thereof, the social innovation perspective is not used to understand how these changes in social practices take place. Social innovation proves to be a useful lens for information infrastructure innovation, especially in the public–private setting due to the complexity in the practices of business-government interactions. Our study shows how which innovations take place with respect to these practices whilst developing public–private information infrastructures. We find that the social innovation can be both an outcome in the form of a certain institutionalized social practice, or a process. In either way, the social innovation co-occurs with the technical development. It can happen simultaneously to create the social setting that is required to reap the benefits of the information infrastructure. It could be that social innovations are required to pave the way for a successful technological innovation.

When institutionalizing these new social practices in a governance arrangement, the innovation is often more sustainable on the longer term, which is not typical for social innovations that start as small-scale initiatives at the grass-roots level (Moulaert et al., 2005; Rüede & Lurtz, 2012). In attempts to sustain social innovations, a typical phenomenon is the integration of successful innovations in public administration institutions. (Moulaert et al., 2005). To make public–private collaborations work, various strategies have been proposed for dealing with stakeholder positions. Some stakeholder management strategies are based on exercising powers (e.g., Frooman, 1999). Alternatively, a process management strategy focuses on defining rules for realizing and maintaining such a process of interaction (De Bruijn, Ten Heuvelhof, & In 't Veld, 2010). A process management approach acknowledges the role

of power, urgency, and legitimacy, but does not neglect the importance of information in decision-making (De Bruijn et al., 2010). The approach aims at achieving negotiated solutions, on which the participants agree after exchanging positions, advantages, and disadvantages. This can lead to new organizational structures and new ways of doing things. Hence, this is typically part of an approach to realize social innovation, especially when also incorporating informal mechanisms and looking at how these mechanisms become more stable through regular use over time. Despite that social innovation literature is often focused on alternatives to state governance through e.g., local community-driven initiatives, this study is among the first to explore how this works in large-scale innovations in information infrastructures that are driven by extensive public–private collaborations.

By focusing on how the social innovation process took place, and looking for changes in social practices among the stakeholders, we found that this was primarily manifest in the discussions and design of the governance arrangements that were being set up to accompany the technical development. We argue that the social innovation perspective should be among the toolkit that researchers use when aiming to understand the actors, the process and outcome of the social part of a large-scale information infrastructure innovation.

We contribute to the literature in two ways. First, we contribute to information infrastructure development literature by untangling the social innovations from the technological innovations. Using the case, we show how information infrastructures lead to potential changes in the social practices among the actors that require an innovation process or new institutionalized practices to channel them, which is required to reap the information infrastructures full potential. Also, we show how the development of public–private information infrastructures can be hard if done in the context of incompatible social practices. This requires that social innovations before actual work can be done with respect to setting up the information infrastructure.

We also contribute to social innovation literature by applying the concept to large-scale sociotechnical developments, occurring in a complex public–private setting and with immediate impact on the social practices of a great number of parties. This is a contribution as the social innovation concept is primarily used in the context of innovations at a smaller, local or individual scale. Also, the perspective of innovations happening on multiple layers is a contribution. This shows the need to put social innovation within the larger context and the developments in other layers. Although there is a lot of work about social innovation, there is scant attention given to social innovation in large-scale public–private innovations. To our knowledge, this is the first study using a social innovation lens to assess the development of public–private information infrastructures. These infrastructures are also an example of social innovations as a product; by reshaping the way data is being exchanged between business and government, public–private collaborations are established to bring structural changes to (state) governance.

This study is limited, primarily due to its explorative nature. Social innovation is here used as a lens based on the general notion of social innovation instead. In further research into this area, this should be structured in a more specific framework to guide the study. Also, we have looked at three development projects and have looked at them as one case. Given the limited scope and the interrelationships between these projects, the lessons cannot immediately be translated to other public–private information infrastructures. A next step in this research should be to design a comparative case study with case selection criteria based on social innovation characteristics.

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