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SYSTEMS INTEGRATION: CONDITION FOR SUCCESS THE CASE OF HAMMARBY SJÖSTAD AND EVA-LANXMEER

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Abstract:
Today, many new urban areas, such as cities, towns, villages, or districts, are being built worldwide and their completion requires the development of a number of infrastructures. Traditionally, these infrastructures are planned in parallel. However, increased environmental awareness is pushing cities to improve their environmental performance. One way to do so is by systems integration (e.g. connecting drinking water pumping with energy production).
The aim of this paper is to show how different actor networks lead to different process of integration. We especially focus on the influence of actor participation during the design phase. To do so, two case studies are presented: Hammarby Sjöstad in Sweden and EVA-Lanxmeer in the Netherlands.

Keywords: systems integration; sustainable urban development; techno-economic network

INTRODUCTION

When new urban areas are being built, their completion requires the development of infrastructures necessary to meet a number of societal functions. Among others there is a need for energy and drinking water provision, waste management and wastewater treatment, or transport facilities. Each of these functions can be conceptualized as being produced by separate socio-technical systems. Traditionally urban planners consider each of these socio-technical systems independently from each other. Infrastructure for wastewater treatment is developed separately from that for transport for instance.
In the last decades, increased environmental consciousness has been pushing cities and municipalities to minimize the environmental footprint of (re)developed urban areas. In

parallel to that, a number of academics have been advocating that in the quest for the sustainable city a transition should be made from linear to circular systems of production and consumption. This is expressed under concepts such as circular urban metabolism (Girardet 1996), cities as sustainable ecosystems (Bossel 1998; Newman and Jennings 2008), urban symbiosis (Van Berkel et al 1009) or symbiocité (Gontier 2005). Behind these concepts lies the idea that interconnections should be developed between different material and energy flows in order to improve efficiency and reduce waste. This kind of thinking is also promoted by scholars from the field of industrial ecology (McDonough and Braungart 2002; Graedel and Allenby 2003).

Therefore, the aforementioned socio-technical systems have to be locally integrated to each other. We will refer to this process as 'systems integration'. Systems integration happens when socio-technical systems initially operating as separate entities become connected. This connection results in new inter-linkages between both social and technical components of the two socio-technical systems. Among others, examples of systems integration are the use of domestic waste for energy provision or the use of the sludge remaining from the treatment of wastewater as source of energy for generating transport fuel. Systems integration is not limited to urban areas. Similar processes of integration can be observed in water management (integrating qualitative and quantitative management, navigation, tourism) industry (industrial symbiosis) or farming (industrial symbiosis in greenports).

Numerous cities and municipalities are making attempts at systems integration (see Joss 2010). However, a wide gap exists between what is theoretically possible and what occurs in practice. Outcomes highly depend on who takes responsibility for the realization of the system, which stakeholders are involved in the design process, to which degree and how. Outcome depends on the characteristics of the actor-network involved in the realization of systems integration. Moreover, the process of realizing systems integration when developing a new district goes through different phases. The system has to be designed, constructed and then operated. In this paper, the analysis will address the design phase only. In practice, it is this phase that determines whether systems integration gets implemented at all and how it will operate once it is there. Two components of the design phase will be addressed: vision building, including both developing a vision for the integrated system and gathering support for it, and the selection of technologies.

In this paper, we argue that the actor-network in the design phase shapes the integration process. This includes both the elements of integration and the extent of integration. The aim of this paper is to show how different actor networks led to different processes of integration.

In the remaining sections, the concept of techno-economic network (TEN) stemming from actor-network theory will be introduced, along with the four poles that compose it. Then, for each case, the analysis establishes which actors played a role during vision building and the selection of technological solutions. We identify whether each pole was filled and which influence this had on the realization of the integrated system. The paper ends with preliminary conclusions and suggestion for future research.

THEORETICAL BACKGROUND: ACTOR NETWORK THEORY

According to actor network theory, the existence of an innovation is bound up to the construction of an actor-world. Callon (1986) stated that "an actor world associates heterogeneous entities. It defines their identity, the roles they should play, the nature of the

bonds that unite them, their respective sizes and the history in which they participate" (Callon 1986).
Moreover, acknowledging that the process of innovation as well as its diffusion requires connection between the worlds of science and technology and the market, Callon introduced the concept of Techno-Economic Network (TEN) (Callon et al 1992). A techno-economic-network is defined as

'a collective set of actors which participate in the development and diffusion of innovation and which via numerous interactions organize the relationships between scientifico-technical research and the market place' (Callon et al 1992).
According to Callon (1992), TEN are organized around three poles:

- Technical pole: design of products and processes that have their own coherence.
- Science pole: the production of scientific knowledge. It includes institutions such as universities, or research institutes.
- Market pole: consumers, suppliers, practitioners, their needs and their preferences.

To the three poles model, de Laat (1996), later followed by Buchhorn (2007), introduced a fourth one around government agencies and public authorities. This is the political pole.

The concept of TEN has been developed in order to understand the processes through which innovation happens and diffuses. As such the scale at which TEN is applied is often rather broad, looking at processes within specific domains but in an entire country (Callon et al 1992; Buchhorn 2007). In this paper, the processes analyzed are, on the contrary, very local. However, there are some important similarities between the processes of systems integration studied in this paper and the concept of techno-economic network as defined above. Systems integration requires the development of technologies that go beyond the scale of individual buildings. A network of heterogeneous actors responsible for the introduction of systems integration will have to be formed. Its role will be about organizing, with a certain extend of political support, the relationship between science, technology and the market.
Nevertheless, we acknowledge that the characteristics of the poles playing a role in the TEN have to be adapted to that of the network studied here. For instance the role of science is fairly different as we are not dealing with science that takes place in laboratories but with the application of scientific knowledge into practice. The four poles are thus described as follows:

- Technical pole: the technologies as artifacts and the organization owning and operating them.
- Science pole: experts with access to scientific knowledge from both private and the public sector.
- Market pole: it remains essentially the same. The analysis will focus on the investors and the end-users. Depending on the size of the project investors could be private companies, and/or local authorities. However, inhabitants may also fulfill this role. The end-users would often be the inhabitants themselves but may also be private companies.
- Political pole: regional or national authorities also play a role by providing political support.

CASE STUDY ANALYSIS

The Hammarby Sjöstad case study builds upon previous research done by one of the authors (Pandis, upcoming) on the development of the Hammarby Sjöstad district. In addition, four semi-structured interviews with people personally involved in the formation of the Hammarby Model and a literature review were conducted. Regarding EVA-Lanxmeer, data presented here are the result of a literature review including a number of reports, brochures, business plan and communication documents written between 1993 and 2008, nine semi-structured interviews and two follow-up interviews.

Hammarby Sjöstad

Hammarby Sjöstad literally means the city around the Hammarby Lake. The district covers an area of 200 Ha. Its development should be finished by 2015. When completed, about 35,000 people would be living and/or working in the area (Fränne 2007).

In the 1990's a number of semi-legal or illegal small scale industries and storage facilities were present in the area which came to be known as the Shantytown (Bodén 2002). Over time the desire to redevelop this area grew stronger in the municipality. At the end of 1995 the city of Stockholm decided to make a bid for the Olympic games of 2004 and to propose Hammarby Sjöstad as Olympic Village (Stockholm Stad 1996). The high environmental performance of the district started to gain importance because the International Olympic Committee was calling for an environmental focus in the applications. This also increased the political interest in the district (Bodén 2002; Green 2006; Enberg and Svane 2007).

<u>Vision building:</u>

In 1996 the City of Stockholm developed an environmental program for Hammarby Sjöstad. In this plan an overarching vision for the district was specified. It stated that *"The environmental performance of the city district should be "twice as good" as the state of the art technology available in the present day construction field (Stockholm Stad 1996 p4)".* Of more importance for this study is the vision concerning the use of energy and material in the district that was also specified. It stated that *"The city district is to be planned and built in accordance with the principles of the natural cycles, the kretslopp."(Stockholm Stad 1996 p4).* It is on this aspect of the vision that we will be focusing. From now on when referring to the vision, we will only be referring to the vision for the integrated technological system in development (the Hammarby Model) and not for the district as a whole (the Hammarby Sjöstad).

Vision building for the Hammarby Model was an interactive process between the City of Stockholm and the local infrastructure companies (referred to as the eco-cycle companies). In 1996, the City invited the eco-cycle companies to propose technological solutions that would materialize their vision. However, they contested this vision and showed little interest. The City and the eco-cycle companies both had different interpretations of the vision. On the one hand the City wanted the companies to develop solutions specifically for Hammarby. On the other hand for the eco-cycle companies closing the loop made sense only if their existing infrastructure could be used. During an interview, the head of the Chief Administration Office, stated that "*the [companies] thought the project was fuzzy and that there already existed a well-functioning infrastructure in Stockholm. Why mess with it?"*

The first proposition made by the eco-cycle companies turned out to be rather "business as usual" and for that very reason was rejected by the City (Pandis and Brandt 2009). In order to push the companies forward, the City made clear that the companies risked losing their share in the project. The eco-cycle companies started mobilizing new employees and made a more innovative proposition. It was based on their existing infrastructure however, individual components would be further improved and new components added in order to better close the eco-cycle. The City embraced this new proposition and encouraged the eco-cycle companies to work further in that direction. A consensus was reached. This also marked the birth of what would later become the Hammarby Model.

Selection of technologies:

Once the vision is developed and has gained support, technological options have to be selected. In Hammarby Sjöstad, some options had already been mentioned during the vision building process. However, they still had to be developed further before they could actually be realized.

Biogas as transport fuel:

Biogas for transport, integrating the sewage system and the transport system is one of the most successful innovations implemented in Hammarby Sjöstad. Biogas is produced in Hendriksdal, the local wastewater treatment facility. Since 2003 the biogas is also upgraded to transport fuel quality in a nearby site.

Pole	Actor involved	Role	Position
Politics	The City of Stockholm	Provide political support	Collaborate
Market	Stockholm Water The City of Stockholm SL (Stockholm public transport company)	Invest Creates a local market, provide subsidies Buy the product	Lead Collaborate Collaborate
Science	Employees from Stockholm water	have knowledge from previous demonstration project	Collaborate
Technical	Stockholm Water	Owner of the wastewater treatment facilities; responsible for the previous pilot project	Collaborate

Table 1*: biogas for transport: actors involved in each pole, their role and position.*

- Political pole: interest in clean vehicle dates back to 1994 when the City of Stockholm had taken the political decision to promote and invest in clean vehicles (Stockholm Stad 2004). In 1996, it also started supporting a pilot project in Bromma where biogas was upgraded to transport fuel.
- Technical pole: Stockholm Water is both owner of Hendriksdal, the plant where biogas is to be upgraded and of the plant where the aforementioned pilot project took place in 1996 (Energie-cites 1999; Held et al 2008).
- Market pole: first, the success of the pilot project encouraged Stockholm Water to invest further in that direction. Second, the City of Stockholm took the resolution to convert its own fleet into non-fossil, providing a market for biogas (Stockholm Stad

2004). Third, the City introduced programs to promote the use of biofuels in the city slowly creating local demand for biofuels (Stockholm Stad 2004). Fourth, SL, Stockholm's public transport company, started considering biogas as a potential fuel in 2002. The company had been previously focusing on ethanol but started having some difficulties with its supplier and decided to diversify its supply (Stockholms Lokaltrafik 2002). In 2003 an official contract was signed with Stockholm Water regarding the supply of biogas (Hallgreen undated).

- Science pole: Stockholm Water had knowledge about biogas upgrading.

PV:

PV integrating buildings and the electricity system were extensively discussed in the early plans about Hammarby Sjöstad. Their large scale introduction was even discussed. However, only very few have been installed and some of those installed are not performing as expected. Looking at the pole, we can see that some instead of working for the technology actually worked against it (see table 2).

Pole	Actor involved	Role	Position
Politics	The City of Stockholm	Provide political support	Support
Market	Fortum Constructors	Invest in the technology Invest in the technology	Initially interested, then arguing against Limited interest
Science	Fortum	knowledge of solar energy, its costs and efficiency	Contest
Technical	Fortum PV	Owner of the district heating company The technology exists	Limited interest Readily available

Table 2*: PV: actors involved in each pole, their role and position*

- Political pole: the City of Stockholm wanted to introduce technologies that were new to Stockholm in Hammarby Sjöstad. PV fell into that category. However, as the project evolved, political support for alternative technologies that did not play a central role in the Hammarby Model diminished (Pandis upcoming). This is partly due to the City losing the bid for the Olympic Games.
- Technical pole: First PV are readily available in the market and show decent performances even in the Nordic Stockholm region (Brogren et al 2004). However, very few PV were present in Stockholm at the time. Another aspect worth mentioning is that most of Stockholm is connected to district heating network and so would the Hammarby Sjöstad. However, Fortum, the company owning the district heating which is mostly based on combined heat and power, saw PV as a competing technology. During an interview, the environmental manager in Stockholm Energi (that would later become Fortum) stated for instance that "*solar energy pushes away cogeneration or other useful techniques*".
- Market pole: Initially Stockholm Energi was interested in investing in PV on a large scale. However, the company later on changed its mind arguing that they were not

competitive. The privatization of Stockholm Energi in 1998 could partly explain this change of attitude. Moreover, the City of Stockholm provided only limited support for project developers to introduce PV who showed little interest. Moreover, when they did, PV were installed according to aesthetic criteria rather than optimal electricity production. The function of the building, in which aesthetics was a primary element, was not effectively reconciled with electricity production (Brogren and green 2003).

- Science pole: Fortum had access to knowledge about PV, their efficiency and their cost from existing project done by other companies but did not have in-house know how. Fortum actually contested that PV were an interesting alternative for Stockholm. During an interview, the environmental manager in Stockholm Energi said that *"during the formation of the Hammarby Model PVs and solar panels were discussed as an alternative, but we knew this was not economically realistic"*.

EVA Lanxmeer

EVA Lanxmeer is a sustainable urban district of 24 Ha developed in the municipality of Culemborg in the Netherlands in the mid 1990's. This municipality is part of the province of Gelderland. In total about 800 people live in the area. Moreover, a number of office buildings are also present on site combining living with working.

The district, which development was initiated in 1993, is the result of an initiative taken by Marleen Kaptein. She was triggered by the momentum developing around sustainability, the Bruntland report had just been published, and by the lack of success from the Dutch government to involve citizens in their environmental policy (Kaptein 2010). Initially, the idea for the district was not bound to any specific location. To be able to enter in negotiations with a municipality she created the EVA-foundation. Using her personal network she gathered renowned Dutch academics and political figures with direct connection to the ministry of Housing, Spatial Planning and the Environment around the project. To show their support they became members of the EVA-foundation.

<u>Vision building:</u>

The process of vision building and support in EVA-Lanxmeer happened very differently from that in Hammarby Sjöstad. The vision for the district to be was entirely developed by experts, including national and international academics and experts from the private sector, free from the influence of local policy makers. The vision included the following elements: an architecture in harmony with the existing landscape; integration of functions: living, working, recreation; reduced use of cars; use of ecological building materials; and most importantly for this paper sustainable water- and energy resource management and the involvement of future inhabitants; education & advice via the EVA-center (Stichting EVA 1995).

The next step was for the EVA-foundation to find a municipality that was willing to realize a district based on this vision. People interested in living in such a district were also looked for. The foundation found support from the Alderman responsible for spatial planning and the environment in Culemborg and from the head of the department of urban development. The municipality already had experience with sustainable building, citizen participation and management of green areas. They had the ambition to go further with urban sustainability and saw the EVA-foundation and its vision as an opportunity to reach that ambition (Stichting EVA; Goed 2010; Kaptein 2010).

Furthermore, Marleen Kaptein also found 80 families that signed a document stating that they would like to live in such a district wherever it would land (Stichting EVA; Goed 2010; Kaptein 2010).

Later on companies were also invited to join in the discussions concerning the specific solutions to be implemented in the district. However, to be able to actively participate in the process, they had to agree with the overarching vision. It was not going to be revised in the process. In fact the EVA-foundation was actually assigned the role of concept keeper by the city and would be guarding the concept or vision throughout the development (Stichting EVA).

Selection of technologies:

Before describing in detail the selection of specific technological solutions, we will first introduce the context in which these solutions were chosen. In 1997, non-professional workshops were organized where inhabitants could express how they wished their future district to look like. Later on, representatives of the inhabitants brought these ideas to professional workshops where they actually influenced the design of the urban plan (Stichting EVA). Even if this does not have a direct influence on the choice for specific technological solutions, this participation is still important to mention. Indeed, the inhabitants participated throughout the process in the design of their neighbourhood and were kept informed by the experts of the technological solutions that were being discussed.

Blackwater treatment and the production of biogas:

Early in the process came the idea to separate blackwater (toilet waste) from greywater (water coming from the kitchen and the shower), to treat it locally using biological processes and to use the remaining sludge to produce biogas integration of wastewater treatment and energy production (Stichting EVA; van Timmeren 2004; van Timmeren 2006). Organic waste produced in the district was also planned to be added to the sludge in order to increase biogas production. These two elements were both planned to be part of the EVA-Centre (see vision) (Kaptein 2010). However, the centre was never realized and with it these two technological solutions did not materialize. A summary of the results of the analysis can be found in the following table.

Pole	Actor involved	Role	Position
Politics	The municipality of Culemborg	Provide political support	Initially interested then released all responsibility
Market	GGR Gas Nuon	Invest in the technology Consume the biogas	Initially interested, then stopped supporting Reject
Science	Energy expert Architect	Knowledge of the treatment of blackwater, the production of biogas and its integration into a building	Provide information
Technical	GGR gas Blackwater treatment and biogas production	Operate the technology	Initially interested then released all responsibility Available

Table 3: *blackwater treatment and biogas: actors involved in each pole, their role and position.*

- Political pole: the municipality of Culemborg initially supported the project. It was part of the vision for the district and the municipality had embraced this vision. However, over time interest diminished and in 2003 the municipality released all responsibility for the project (Kaptein 2010). This can partly be explained by the fact that the civil servant initially supporting the project left the municipality, and partly because during the time frame of the project, different municipal councils succeeded one another. New council members did not understand what was going on in EVA-Lanxmeer anymore (Kaptein 2010). The project leader for EVA-Lanxmeer employed in the spatial planning department also mentioned that "*the project was too ambitious for somewhere like Culemborg*".
- Technical pole: the company "GGR gas" was initially expected to operate the biogas installations. However, the company later on stopped its support (Bonouvrié 2010; Kaptein 2010). Moreover, for biogas to be produced blackwater treatment had to be done locally. The two technologies were intimately connected to each other. However both had already been introduced elsewhere in more or less large scale.
- Market: Large amount of biogas were expected to be produced and a market had to be found outside the district. One solution considered was to send (part of) it back into the gas network. However, Nuon, a Dutch energy company responsible for the gas grid in that area, rejected the idea (Bonouvrié 2010). There were thus many uncertainties regarding the availability of a market for biogas that was to be produced. This also partly explains why no large investors could be found for the project.
- Science: energy experts and architect worked on the EVA-concept. Scales models were made, together with a number of calculations and academic publications (van Timmeren 2004; van Timmeren 2006; van Timmeren 2007). Technical knowledge was thus available during the process.

Local treatment of greywater:
Part of the water concept was to locally treat the greywater produced in the district integration of wastewater treatment and aquatic ecosystem. This includes water coming from the kitchen and the bathroom. This was one of the solutions successfully implemented in the district (Stichting EVA).

Pole	Actor involved	Role	Position
Politics	The municipality of Culemborg Water board Rivierenland	Provide political support Provide support	Support Collaborate
Market	Future inhabitant Water board	Produce the greywater Financing and maintain the system	Participate Collaborate
Science	Academic and private experts Arcadis	Provide information Provide information	Inform Inform
Technical	Brinkvos water	owns the technology to build the system	Available

Table 4*: local treatment of greywater: actors involved in each pole, their role and position.*

- Political pole: First the municipality of Culemborg supported the idea from the very beginning. Second the Water Board Rivierenland, a regional government body responsible for maintaining the level and the quality of the water in the area also supported the project (Bonouvrié 2010; Kaptein 2010)
- Technical pole: greywater treatment in Culemborg was new. However similar systems had already been built elsewhere. In EVA-Lanxmeer, technical calculations were done by Arcadis, a Dutch engineering firm.
- Market: First the Water Board Rivierenland played an important role here by allowing such an experiment to be realized (Verhaagen, 2011) and by financing it (Bonouvrié 2010; Kaptein 2010). Second the future inhabitants were kept informed of the technological solution chosen and their implications (Stichting EVA). This has been very important as for the biological treatment of greywater to function properly, chemical products such as bleach can't be thrown into the sink. Inhabitants thus have to adapt their behavior to the system in place.
- Science: academic and private experts, and Arcadis all provided information about the greywater system (Stichting EVA).

DISCUSSION AND CONCLUSION

The aim of this paper was to show how different actor networks led to different process of integration. The focus was on the influence of actor participation during the design phase, including vision building and selection of option. We used the concept of Techno-Economic Network developed in order to understand innovation processes to analyze attempts at systems integration in two case studies: Hammarby Sjöstad in Sweden and EVA-Lanxmeer in the Netherlands. It total four different attempts at systems integration were studied. A summary of the results can be found in table 5.

First, our results show two very different approaches to vision building. In Hammarby Sjöstad, as initiator, the City of Stockholm developed a vision and then tried to get support from local infrastructure companies. However to do so she had to both pressure the companies and agree to make some compromises. In fact, vision building was not a purely separated process but was also influenced by the initial selection of technological options. Moreover, we can see a dominance of two groups of actors: the City of Stockholm and the eco-cycle companies. We can also note that technology related actors have a prominent role while future inhabitants did not have a say in the process. We can observe that discussions focused on closing material and energy cycles through technological solutions.
In the case of EVA-Lanxmeer however, a number of experts developed a vision and looked for partners interested in working with that vision. The partners they sought were a municipality and future inhabitants. In this vision, the technological component only played a marginal role. No location was known when the vision was built so it had to be stated rather general to give space for local specificities to be expressed. Moreover, technical partners were later invited to join in the discussions but on the conditions that they agreed to work with the vision. It is the process through which these technological solutions were to be chosen, in interaction with the inhabitants that was given the most attention.

Regarding the specific technological solutions chosen, our analysis unsurprisingly shows that the two cases where implementation was successful had all the poles filled and often by more than one actor. Concerning biogas production in Hammarby Sjöstad, a variety of partners with different expertise gathered around the project. They all found interest in biogas either as a way to expend their market, or to help meeting their corporate ambitions. The market and the science pole were filled by more than one actor ensuring the availability of knowledge and the presence of a future market for the product in development.

In EVA-Lanxmeer, generally speaking, the context in which the district developed was favourable for experimenting. Actors with political power were inclined to support, politically and financially, innovative solutions such as greywater treatment. The science pole was strongly represented giving credibility to the solution and its feasibility. The market pole, through the future inhabitants, was also well represented. This was especially important given the role that inhabitants have in ensuring the proper functioning of the system. However, this raises questions regarding the long term operation of such a system as new inhabitant have to be kept informed of the existing rules. This is especially challenging in situations where there is no formal institutional setting and where responsibilities are not clearly distributed. In EVA-Lanxmeer, it is the inhabitants themselves that, out of their own will, are organizing knowledge diffusion in the district.

Stage	**Pole**	**Hammarby Sjöstad**		**EVA-Lanxmeer**	
Vision building	Politics	Yes		No then yes	
	Market	No then Yes		No then some yes	
	Science	Yes		Yes	
	Technology	Yes		No	
Choosing specific technologies		Biogas	PV	Biogas	greywater treatment
	Politics	Yes	Yes	Yes then No	Yes
	Market	yes	No	No	Yes
	Science	Yes	No	Yes	Yes
	Technology	Yes	Yes	Yes and No	Yes
Final result		Introduction successful	Introduction very limited	No introduction	Introduction successful

Table 5*: Summary of the findings. The words "yes" and "no" are used to express whether the pole is filled or not.*

Concerning solutions that were not realized, our data also tends to show that independently, political support (political pole), technological feasibility (technical pole) and knowledge availability (science pole) are not sufficient for systems integration to be realized. Moreover, in the two cases where implementation failed, the market pole was very weak. In the case of PV in Hammarby Sjöstad, the technology was readily available. However, it did not fit in the portfolio one of the key actor who even contested the usefulness of introduction. Moreover, shifting political support failed to create a real market for PV in the district.

Looking at backwater treatment and biogas production in EVA-Lanxmeer, out of the four poles, only the science one was actually fully represented and was actually driving the realization. The market was rather insecure and uncertainties remained around who would be building and operating the system. Political actors provided insufficient support, unconvinced of the economic feasibility of the project.

To conclude, results presented in this paper show that, as expected from the theory, all poles need to be filled for a successful implementation to happen. Results also show that partial implementation can be realized with only a few poles active. Moreover, the analysis suggests that the market pole is difficult to fill and that market actors are difficult to convince to join in systems integration practices.

These results also raise a number of questions. First, in this paper the analysis only shows the final results of various attempts at systems integration. A chronological analysis showing how the poles get filled from the moment when the idea was developed to its realization (or abandonment) would better reveal which pole drives the process and the dynamics behind systems integration. This may also reveal when and under which condition does the market pole start being filled. Moreover, the analysis done here shows what happens but does not explain why actors decide to join the process or not. Each actor, whether they are doing public transport, wastewater treatment, district heating, etc. is part of a socio-technical regime. This regime sets the norms and routine that drive actors and their activities. Including a more in-depth investigation of the actors and the regime to which they belong would give explanatory power to the analysis.

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