HARNESSING DIGITAL ECOSYSTEMS THROUGH OPEN DATA – DIAGNOSING THE SWEDISH PUBLIC TRANSPORT INDUSTRY

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Research in Progress

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Abstract

In this research-in-progress paper, we present findings from the diagnosing phase of a Canonical Action Research endeavour, together with the Swedish public transport industry. In our investigation, we found that the Swedish public transport industry historically has been able to create substantial value from taking a peripheral position in existing digital ecosystems. Also, we found several types of digital ecosystems that potentially would create future value, using open data from the public transport industry. These ecosystem types are incumbent digital platforms, open source software frameworks, and multi-provider open data ecosystems. This finding is novel to current discussions, as our results point to the paradoxical necessity of taking a more peripheral position towards these nascent digital ecosystems in order to harness their value. This finding implies a need for data providers to develop capabilities that enable such ecosystem participation. Our emerging results suggest that such capabilities include complementary resources, input control compliance, IP waivers, open community practices adoption, and open data boundary-spanners.

Keywords: Open Data, Digital Ecosystems, Public Transport, Canonical Action Research.
1 Introduction

For some 15 years, many governments around the globe have published its internal datasets publicly with little or no reuse restrictions – open data. These datasets cover a wide variety of public services ranging from expenditures and tenders, environmental sensors, weather forecasts, and public transport networks. The overall argument for publishing such data include viewing open data as a way of giving data back to citizens, increasing governmental transparency, and as basis for innovative entrepreneurs.

While the promise of value creation from open data is prevalent, data publishers are still struggling with realizing its value (Janssen et al., 2012). Mobilizing re-use is at the core of such value realization, but the role that governments should take in this process is contested (Sieber and Johnson, 2015). Some argue that governments should merely focus on data publication (O'Reilly, 2011), in formats as close to its native format as possible and leave other value-adding activities to market and community actors. Others, however, argue that a more proactive and facilitating role by governments is a necessity to propel the re-use of open data (Sieber and Johnson, 2015). Governments that are assuming a more proactive approach, have faced that building bilateral relationships in particular areas (such as posing specific, societal challenges to be tackled by the crowd) with re-users is both costly and carries high degrees of risk (Susha et al., 2015). To this end, open data scholars have instead started to view open data through an ecosystem lens (Harrison et al., 2012, Dawes et al., 2016). This view asserts that important ecosystem characteristics such as temporal dynamics, actor interdependencies, and governmental interventions is necessary to increase and sustain value creation from open data (Dawes et al., 2016). This important research focuses on holistic ecosystem dynamics assumes open data as the focal resource, that other ecosystems actors depend on.

While this argument in many circumstances has merit, we in this paper investigate an alternative view of ecosystems, in order for governments to increase the value creation from open data. Instead of growing an ecosystem where data providers take a focal position, we explore how value creation from open data could be approached by open data providers assuming a more peripheral position to existing and emerging ecosystems (Selander et al., 2013). By adapting to the needs and governance regimes of these ecosystems, data providers can create value from its open data, by using these ecosystems’ digital resources, innovators and end-users. To this end, we in this paper pose the following research question: Why and how can open data providers as non-focal actors harness value from adjacent digital ecosystems?

The paper is structured as follows. First, we begin by reviewing relevant literature on open data and digital ecosystems. Second, we present our research approach by introducing our research setting, the diagnosing phase of a Canonical Action Research project (Susman and Evered, 1978) together with the public transport industry in Sweden. In this section, we also explain also what data that has been collected and how it was analyzed. Third, we present this industry’s historical experiences, concerning responses to external digital ecosystems. Fourth, we present the industry’s view of new, insofar untapped ecosystems, from which the industry could derive future value. We conclude this paper with a discussion on our results and a proposal for the next step for this research-in-progress.

2 Open Data

Open data is in our ongoing research is defined as internal data passed on beyond an organizational border (Marton et al., 2013), where intellectual property rights have been relinquished or reduced to a minimum (Auer et al., 2007). Often such open data is made available through open Application Programming Interfaces in machine-readable formats (Latif et al., 2009) to facilitate integration. Open data in this form is typically intended to be used by external developers, enabling these innovators to create value by accessing data through the platform’s boundary resources (Bonina et al., 2018). While private sector service innovation often is the target for such designs it also enables service innovation from the public sector (Zuiderwijk et al., 2014). Moreover, Safarov et al. (2017) point toward more analytic utilization, where open data is used, e.g., for data analytics, decision making, and research. Finally, Ubaldi (2013) point towards that open data can facilitate collaboration between organizations, e.g., data
exchange between governmental agencies. Hjalmarssson et al. (2015) identifies several actor types that could both benefit from and provide resources into a collaboration based on open data. The data provider is a type of role that represents the most upstream supply-side of open data resources. In a development-oriented collaboration, this data is consumed by third-party developers that innovate open data services on commercial or non-commercial grounds. This data is either provided by data providers themselves or by external open data publishers, acting as open data brokers effectively facilitating the collaboration between actors. A fourth actor type in open data collaborations are the customers, that is consumers of products and services that are based on open data as an essential enabling resource.

Dawes et al. (2016) develops the notion of open data collaboration into a preliminary ecosystem model for open data programs. This model is used as a base to develop open data ecosystem elements to explain but also create tools to establish such ecosystems. As the primary hub in such an ecosystem, Dawes et al. (2016) defines the open data provider which they split into decisions makers (that provide legitimacy and resources to the ecosystem) and administrative agencies (that ensure data publication). Janssen and Zuiderwijk (2014) acknowledge that value creation in such systems likely will involve both public and private organizations where each organization contributes to the value creation. These dynamics suggest that an ecosystem view is fruitful to understand how added value can be created for users based on open data. The creation of value through open data in an ecosystem is an evolving relationship, one where the type, degree, and directionality of data sharing will determine how data is used and exploited for different benefits (Sieber and Johnson, 2015). In the drive for efficiency in the data sharing operations, Sieber and Johnson (2015) argue that governments should maintain focus on effectiveness and improvements. They argue that governments as data providers must ensure that value for citizens and government are being attained compared to value exclusively for corporations, and that the key to such value attainment lies in coordination efforts based on a focal hub position in the digital ecosystem.

3 Digital Ecosystems

We define a digital ecosystem as “a distributed adaptive open socio-technical system with properties of self-organisation, scalability, and sustainability” (Jansen and Cusumano, 2013, p. 18). In a digital ecosystem, service development is described as mimicking the characteristics of a natural ecosystem (Moore, 1993). A thriving natural ecosystem in equilibrium is characterized by symbiosis, where different organisms can sustain habitat survival as a result of their relative diversity towards – and interactions with – other organisms in the ecosystem. A growing body of literature has thus used ecosystems as a metaphor to convey the dynamics of simultaneously cooperating and competing actors seeking to mutually propel a particular shared interest (e.g. a new technology) (Selander et al., 2013, Basole, 2009, Wareham et al., 2014, Iansiti and Levien, 2004, Bosch, 2009, Lindgren et al., 2015). The topic of how ecosystems emerge is an ongoing and relevant research topic. Jacobides et al. (2018) argue that ecosystems do not merely emerge spontaneously. Instead, they are the outcome of deliberate trials and designs from different organizational actors attempting to elevate value through collaboration. They argue that “an ecosystem is a set of actors with varying degrees of multilateral, non-generic complementarities that are not fully hierarchically controlled.” (Jacobides et al., 2018, p. 2264). The lack of fully hierarchically control of ecosystem means that decision-making in ecosystems to some extent is distributed even if the ecosystem has a key hub actor. This lack of control connects Jacobides et al. (2018) view on eco-system with the view of Jansen and Cusumano (2013) as both sources describe a distributed and adaptive system that self-organize in order to coordinate actions.

Most studies on digital ecosystems have primarily inquired into focal firms (West, 2003, Wareham et al., 2014, Gawer and Henderson, 2007, Eaton et al., 2015, Ghazawneh and Henfridsson, 2013). However, as argued by Selander et al. (2013), a mere few can expect to act from such a central and commanding position (Schilling, 2002) – albeit still benefit from ecosystem participation. The large body of non-focal actors instead needs to make strategic decisions about what ecosystems to participate in or redraw from, instead of trying to establish new ones. By actively searching for and redeeming innovation capabilities in nascent ecosystems (Selander et al., 2013), successful non-focal organizations may in a cost-efficient manner draw on ecosystem resources, e.g., third-party developers.
In our research, we thus explore this alternative view of ecosystems behavior to increase the value creation from open data. Instead of just nurturing an ecosystem where data providers take a focal hub position with the hierarchical ambition to control the system, we explore how value creation from open data could be approached by open data providers assuming a more peripheral hub position to existing and emerging digital ecosystems. Given this theoretical background, we now dive into our research, investigating how open data providers may derive value from peripheral ecosystem participation.

4 Research Approach

The findings presented in this paper stem from a diagnosing phase of a canonical action research (CAR) venture (Susman and Evered, 1978) between several public transport actors in Sweden and the authors of this paper. The overarching purpose of this collaborative research project was to increase the use of open data published by the Swedish public transport industry as this industry that was amid radical transformation regarding its open data. In 2016, the Government Offices of Sweden, through “Forum for Transport Innovation,” ignited a redesign of open public transport data in Sweden. The primary reason for this initiative was to create a more comprehensive and harmonized open data delivery from the public transport industry. For instance, real-time data were only available in a few regions, and the datasets from different regions were difficult to combine. As a result of this 9-month work (consisting of interviews, workshops with public transport experts and mobility services developers, and management decision meetings), five strategic objectives were eventually formulated and accepted by the public industry as a whole.

One objective concerned the new organization specifically stressed the importance of finding new, innovative ways to increase the diffusion of open data and services. The first author of this paper introduced the idea of public transport assuming a more peripheral position in digital ecosystems (Selander et al., 2013) as a novel way of increasing diffusion of open public transport data. To achieve this, it was necessary for the industry to develop required participation-enabling capabilities – work that could be performed as an action research project. This potential overlap between research and practitioner interest, thus became the entry point of the diagnosis presented in this paper. However, engaging in CAR infers adhering to the principle of having the researchers performing an independent analysis before any interventions (Davison et al., 2004). Thus, we embarked on a diagnosis, investigating the usefulness of applying a peripheral ecosystem participation perspective (Selander et al., 2013) as a way to analyze and structure the problem (Mathiassen et al., 2012) of increasing open data diffusion.

Data was collected in several steps. First, the researchers collected both the final report and the detailed notes from the six workshops leading up to industry ratification of the five strategic objectives (presented above). This way, a more thorough and coherent understanding of the public transport industry’s strategic challenges and plans was possible. Second, we used research material collected for previous research ventures (Rudmark et al., 2012, Koutsikouri et al., 2018), in order to get a historical view of the industry’s historical encounters with digital ecosystems. Third, the first author of this paper interviewed representatives from the public transport industry involved with open data, having positions both on a technical and strategical level (N=11), to uncover potential untapped digital ecosystems, their benefits and finally the capabilities necessary for increasing the use of open data. These interviews lasted between 60 and 90 minutes, were conducted face-to-face or via video conferencing software. All interviews were recorded and transcribed. Fourth, the first author visited public transport actors in Finland and Norway, in order to collect data (field notes) on how these organizations work with open source and OpenStreetMap. Finally, the authors of this paper conducted a workshop with public transport representatives, where the preliminary findings were discussed and elaborated. The workshop lasted for 3 hours and was recorded and transcribed.

Our approach to data analysis was designed to fit the nature of our research question. To this end, we used our theoretical review as an initial sensitizing device (Klein and Myers, 1999), when coding our empirical material in Atlas.ti. This way, we were able to identify

1. antecedents, enabling capabilities and results from historical uses of digital ecosystems
52. insofar untapped digital ecosystems in which public transport participation would be beneficial. The analysis allowed us to unveil research participants’ hypotheses around necessary capabilities to harness these untapped ecosystems.

5 Diagnosing pt. 1 – Historic Harnessing of Digital Ecosystems

A crucial part of the public transport industry is keeping the passenger informed and up-to-date on available routes, fare information and notification of disturbances in the system. To this end, public transport agencies worldwide have allowed the public open access to their internal resources, including timetables, stops registers, travel planning services, and real-time positioning data. While the public transport industry on a national level has been considered a “trailblazer” for other public sectors, our findings point to that the impressive growth has been closely related to the establishment of linkages to existing digital ecosystems – rather than the cultivation of new ecosystems from scratch. In this section, we zoom in on two such historical developments and then continue elaborating on additional digital ecosystems, ripe for public transport data, and the capabilities needed to harness them.

5.1 Smartphone apps

Before the advent of smartphones, the Swedish public transport industry had been reluctant to disclose its data and services openly. However, as the Swedish society became permeated by internet-connected smartphones from the late 2000s and onwards, there was a surge of interest from independent third-party app developers, seeking to convey public transport information to smartphone users. As no sanctioned interfaces for developers existed, developers re-sorted by scraping data off official web pages. Some of these unsanctioned smartphone apps reached unanticipated popularity with the travelers, and even though a legal investigation was made on how to discontinue these services, their popularity made it very difficult from a public relations standpoint. Moreover, in 2009 Stockholm public transport started to publish APIs, allowing third-party development but under the far-reaching license agreements, very few app developers (except those explicitly persuaded to) enrolled in the program.

To create a more sustainable situation, the public transport industry through its co-owned company Samtrafiken, founded Trafiklab.se. The platform contained a variety of resources, designed to fit this new breed of actors that could help public transport to distribute traffic information more pervasively: a set of APIs for travel planning, disturbance, and real-time information, a new, permissive license for the use of data and an online support function. Also, Trafiklab.se started to initiate developer meetups, where developers could meet face-to-face and interact directly with public transport officials.

Two years after the inception of Trafiklab.se, some 35 applications were available within smartphone app marketplaces. Two of these apps served some 350 000 users on a daily basis. As such, the response to the needs of the smartphone ecosystems had created significant value for the public transport industry.

5.2 Google Maps and GTFS

In early 2012 public transport in Sweden was approached by Google, who sought to enrich Google Maps’ routing services. Google maps were at the time among the most popular maps application, and the routing functionality included walking, driving, and cycling. Google wanted to add public transport as a transport modality and was contingent on retrieving public transport data for stops and stations, timetables, and routes. While Trafiklab.se initially offered Google the existing travel planning APIs, these interfaces were declined by Google. The reason for this decision by Google was Google Maps’ dependence on its routing algorithm – and the APIs offered by Trafiklab.se did not decouple the underlying data about the transport network and schedules from its routing algorithm. Google had at this point obtained such data from a large number of public transport actors around the globe, and in order to streamline this process, Google had created a standard called “Google transit feed specification” (GTFS). Effectively, this standard prescribed that network and timetable data to be exported as a text-based relational database. Given the apparent benefits of being part of Google Maps’ routing functionality, a wide array of public transport actors had already accepted Google’s demands and were exporting...
their data following the GTFS specification. Besides, however, many public transport organizations were not supplying Google exclusively with this data. Instead, they were openly publishing these feeds, serving a multitude of third-party developers. Given the emerging de facto standard emanating from Google’s data requests, a vibrant ecosystem had emerged, based on GTFS. The public transport industry (through Samtrafiken) eventually agreed to export the requested data following GTFS. Apart from the specified format Trafiklab.se also needed to comply with a specific quality assurance process prescribed by Google. If the data did not pass these quality checks, it was not published on Google Maps. In addition to enabling public transport as a routing option in Google Maps, this response to an existing ecosystem had rendered a wide array of new services, that was a part of the GTFS ecosystem. These ecosystem resources included an inflow of existing, international services such as Moovit, CityMapper, and Trafiklab.se assessed the Swedish market as more accessible.

6 Diagnosing pt. 2 – Untapped Digital Ecosystems

6.1 Incumbent Digital Platform Ecosystems

The first category of untapped digital ecosystems concerned Incumbent Digital Platform Ecosystems. This category referred to where the ecosystems are contingent on a mediating multisided platform (Tiwana, 2014). These ecosystems were typically operating on a global scale, and the above reported Google Maps example represents an example of such a platform. Platforms that was brought up in the interviews was Apple Maps and OpenStreetMap, as well as a more in-depth collaboration with Google Maps. Through these platforms, the open data from public transport could be spread to all users of that platform. E.g., if Apple Maps used open data around public transport network and scheduled traffic, all users of iOS devices would be able to do route planning in the native map application. In addition to this, the OpenStreetMap platform afforded to leverage the platform’s mapping community. Examples of such ecosystem services were corrections from mappers on bus stop locations and access to walking links, which was not always available in official maps, as commented by a business area manager:

Smaller actors might very well be able to develop excellent niche services, but it’s through the major actors that open data delivers – that’s how you get the information out to travelers.

Also, many respondents mentioned sustainability as an essential benefit of such an eco-system engagement. In this regard, these platforms addressed a significant issue that smaller third-party developers struggled with – the existence of a viable business model. An open data strategist commented:

It’s these large actors that can produce sustainable services because there’s always a business case in the foreground. They don’t do anything without user needs and a business model to monetize the service.

Regarding barriers, respondents pointed to the relative power imbalance between these keystone actors and public transport, as commented by representatives of regional public transport authorities:

They set out far-reaching requirements on our data delivery, but we don’t have any say about if they were to take our data offline

And you must adapt to their demands. Then you’re totally in their grip – it gives you kind of a bad stomach feeling.

In order to harness Incumbent Digital Platform Ecosystems, the diagnosing phase revealed that the public transport industry needed to develop several new capabilities. First, the proprietary platforms required complementary resources (Grover and Kohli, 2012), in addition to the open data. For instance, Apple Maps required public transport partners to provide not only scheduled data in GTFS, but also graphical elements, used by the public transport in, e.g. subway signage, to maintain a coherent user experience for iOS users. Also, these large platform providers required that the public transport actors go through a quality assurance process. In such an ecosystem, input control compliance (Tiwana, 2015), datasets that were to be imported into the digital platforms were checked for consistency and errors and required responsiveness from public transport actors. Similarly, to harness OpenStreetMaps, there was a need for additional IP waivers (Demil and Lecocq, 2006) where the data provider needed to give up the copyright for the data. Currently, the data was released under a permissive but custom license, but...
OpenStreetMap required that data was using an international, non-copyright license, such as CC0. Also, the experiences from Norway suggested that understanding the mapping procedures of the community and community relationship management was a necessary precondition for harnessing OpenStreetMap. We denote this capability open community practices adoption (von Hippel and von Krogh, 2003).

6.2 Open Source Software Framework Ecosystems

The second category of untapped digital ecosystems we denoted Open Source Software Framework Ecosystems. These types of ecosystems relied on a particular open source software framework alongside a community of developers (Jansen and Cusumano, 2013), many of who possessed in-depth knowledge about public transport operations. The most prevalent example of such an ecosystem gravitated around the open source route planning algorithm OpenTripPlanner. Through this framework, third-party developers can use open data about the transport system and generate journey options for public transport but are beside able to add other modes of transport, such as hail-riding services or rental bikes. However, configuring such journey planning in accordance with public transport official route planning was cumbersome, and if the public transport industry were to engage more in, e.g. both the OpenTripPlanner community and provide reference implementations, it was thought to remove the burden from third-party developers (as had been done in both Finland and Norway).

All respondents were positive toward closer collaboration with open source ecosystems for a variety of reasons. These included the possibility to give back to the society, to increase the agility to changing business demands but also to use these open source framework ecosystems as a way to distribute encapsulated public transport knowledge – and thereby increase the use of open data, as commented, by an open data principal:

I’m convinced that you should build on others’ ideas and knowledge, rather than start from scratch. If you have something useful, then you should share it. I believe you get “more bang for the buck” if it’s possible to make use of others’ ideas. It’s like science, if all start from zero, you won’t get anywhere.

When it comes to barriers, respondents pointed to the relative immaturity of using open source within the Swedish public transport industry. This crude experience meant that there was a lack of knowledge on how to work these communities and their reciprocal practices. Moreover, the issue of licensing was an issue brought up by respondents. For instance, should companies embrace a “copyleft” or “copyright” approach, what is allowed to publish given that public organization should disturb markets, etc.? A strategy manager in the public transport industry commented that:

There are several legal issues as well: if we developed something, are we allowed to share it with someone else when we used tax money, or can we even destroy markets this way? There’s a whole range of issues that we need to address since open source is a new way of working to which we don’t have any answers today.

In order to harness these ecosystems, our diagnosis surfaced two critical capabilities necessary to harness digital ecosystems building on open source frameworks. First, choosing what IP waivers (Demil and Lecocq, 2006) that would capture the most value from open source ecosystems, was a challenging issue. Second, open community practices adoption (von Hippel and von Krogh, 2003) was considered crucial to such ecosystem harnessing by the respondents.

6.3 Multi-Provider Open Data Ecosystems

The third category of digital ecosystems we denoted Multi-Provider Open Data Ecosystems. In this case, most respondents referred to the work on open data on a national level, and how the public transport could draw from this work (Dawes et al., 2016). However, in the discussions with respondents, it was discussed that such ecosystems could include both more regional ecosystems, as well as other modes of transport, beyond public transport. At the center of such an ecosystem was an open data portal, providing reusers with a catalogue of available data. Also, several governmentally-sponsored initiatives to spur the use of open data and innovation contests with high visibility was a part of this ecosystem. By drawing on this larger open data ecosystem, it was thought that a wider pool of re-users could be recruited.
A number of benefits were brought up as perceived benefits from participating in such ecosystems. For instance, including public transport data in national initiatives but also gaining knowledge from other governmental agencies on how to work with open data. Besides, by working together, a more harmonized way of publishing data could be achieved, as commented by an open data principal:

*However, I believe there’s a huge potential if governmental agencies would coordinate more, that way you would become more of a market for different actors who want to come to Sweden. Because I do believe that Sweden has potential, with a population with a high app and internet usage. And then an actor might think – “yes, Sweden would be an interesting market to try out” – but this requires a much wider offering of datasets, public transport data alone is just not enough.*

The barriers to such ecosystem participation primarily concerned collaboration. The data from the public transport industry was already in the national data portal – but still, little value was created through the national open data ecosystem. This lack of synergy was thought to be caused by a lack of engagement with ecosystem actors.

*The reason we are not working with other governments on open data is that this issue has not been prioritized and that it is hard. It comes down to sporadic contributions from enthusiasts. There is no ready-made way of ‘yes, this how we work together on these issues.”*

While respondents gave rise to several potential future capabilities (such as data harmonization and integration), the immediate need was outreach towards these open data ecosystems. Given the lack of contribution, our diagnosis suggested a need to constitute more institutionalized open data boundary-spanners (Williams, 2002) within the public transport industry.

### 7 Diagnosing: Reflection and Learning

In this paper, we have investigated the following research question: Why and how can open data providers as non-focal actors harness value from adjacent digital ecosystems? Our investigation showed that substantial value had been created from open public transport data, as a result of taking a peripheral position in digital ecosystems (Selander et al., 2013). We observed this significant value creation as open data became an auxiliary resource in both the smartphone, Google Maps, and the GTFS re-use ecosystem. Moreover, through this inquiry, we also discovered new, insofar untapped ecosystems, from which the public transport industry could derive future value through participation. These untapped ecosystems included incumbent digital platform ecosystems, open source software framework ecosystems, and multi-provider open data ecosystems.

A closer look at how this value creation was made possible, we in the smartphone apps ecosystem found that these mechanisms were developed largely on a trial-and-error basis (Jacobides et al., 2018) over more than two years, before reaching a state of ecosystem equilibrium. The process of onboarding Google Maps’ ecosystem, on the other hand, was a much more streamlined process, as both resource design (GTFS) and boundary processes were predefined. However, an essential distinction between historical ecosystem participation experiences and the untapped ecosystems unveiled in the diagnosis phase concerns the origin of the necessary thrust to establish the links between the open data provider and the digital ecosystem. In the experiences from smartphone apps and Google Maps, these were exogenous to the public transport industry, pushing public transport to develop appropriate mechanisms to align with these ecosystems. The untapped ecosystems however, seemed to require a more proactive approach, and together with the knowledge gap on non-focal ecosystem participation in open data, we thus find this setting ripe for an action research venture. Also, by looking closer at the mechanisms that enabled such ecosystem participation, an increasing awareness emerged around the needs to develop necessary ecosystem capabilities within the public transport industry. As a natural next step, *action planning*, the research team will, together with public transport participants, further investigate the nature of such capabilities. As a theoretical point of departure, we will follow Tan et al. (2015) and draw from existing capabilities research, from both information systems the platform literature, to help inform such an intervention.
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