Open Data and Open Source Enabling Smart City Development: A Case Study in Häme Region

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> *"In God we trust, all others bring data."*
>
> W. Edwards Deming
> Father of quality management

Open data offers possibilities to accelerate both innovations and co-creation activities in cities and regions. Likewise, open source software development is an efficient way to create new services. Open data can be used to promote better information sharing and offers various opportunities for third-party developers. Co-creation improves the commitment of different stakeholders and ensures that the created solutions are based on real needs. For these reasons, it is only logical that these two themes are linked together in smart city activities. This paper presents a practical open data and co-creation development made in the region of Häme, Finland.

This paper contributes to smart cities research by describing the development of two smart city services: the Tavastia Events API and "Hämeenlinna in pocket" smartphone application. It describes strategies that facilitate beneficial participation and collaboration in smart city open data initiatives. Based on Linked Events, an open source solution developed for the city of Helsinki, modification and implementation were made to create a centralized and open service, to collect and publish event-related data via an application programming interface (API) in the Häme region. A smartphone application was then developed, making use of the developed Events API and other data sources, to provide citizens with the most common digital services, and a platform for digital participation in Häme.

Introduction

The role of the city is expanding from being a producer and buyer of services to being an innovator of services (Ojasalo & Kauppinen, 2018) and creator of ecosystems (Cotton, 2018). Digitalization and increasing demand for digital services are not only changing the way the citizens use public services (Jussila, Lehtonen, Sillanpää, Helander, & Kallio, 2016), but also how value is co-created between public organizations, companies, citizens, and other value network partners. Public organizations are among the largest creators and collectors of data that is valuable to citizens, organizations, and businesses for participation, decision making, and creating innovative products and services (Janssen, 2011). Many government agencies, including cities, have established initiatives to make their data available for public consumption (Chan, 2013; McDermott, 2010) also called open data initiatives. Open data refers to data "that is technically and legally made available for reuse and republication (Lindman & Rossi, 2013). However, it is important to recognize that while open data initiatives function as an enabler for citizen and company participation and collaboration, there is no assurance that such initiatives actually result in any purposeful or beneficial participation and collaboration (Chan, 2013).

In parallel with open data initiatives, open source is also gaining traction with governments. Open source refers to software development that results in open source code. According to an internationally recognized Open Source Definition (https://opensource.org/definition), only software licensed and distributed that meets the ten criteria introduced in the definition should be labeled open source software (Lindman & Nyman, 2014; Nelson, 2007). Open source has the potential to scale up by incorporating the work of many (Garzarelli, Limam, & Thomassen, 2008), and provides cities, for example, with opportunities to learn and make use of solutions developed in other cities. Not only can a city save costs

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by reusing and modifying existing solutions, but it can also gain additional development resources when multiple cities participate and collaborate in software development. Open source provides the opportunity to create smart city platforms, following the Triple Helix (Etzkowitz, 2003) model of an institutional triangle of government, business, and academia, as well as adding citizens and users to the mix, thereby forming a so-called Quadruple Helix model (Carayannis & Campbell, 2010).

The development of smart city platforms suggests that, increasingly, new services may be offered to citizens and that their delivery will be more efficient in terms of time, cost, and the number of citizens reached (Visvizi & Lytras, 2018). Citizens should not, however, be considered merely as users, but also as stakeholders having an active role as participants, collaborators, and developers in the city's activities (Kunttu, 2019).

The concept of a smart city has received considerable academic interest. Dameri (2013) attempted to create a comprehensive definition of the smart city and concluded that "a smart city is a well-defined geographical area, in which high technologies such as ICT, logistics, energy production, and so on, cooperate to create benefits for citizens in terms of well-being, inclusion and participation, environmental quality, and intelligent development; it is governed by a well-defined pool of subjects, able to state the rules and policy for the city government and development". Anthopoulos and Fitsilis (2014) define a smart city as an ICT-based infrastructure and services environment that enhance a city's intelligence, quality of life, and other attributes (i.e., environment, entrepreneurship, education, culture, transportation etc.) One interesting addition to the concept of the smart city is the concept of smart community. Giffinger and Gudrun (2010) define 'smart community' in the following way: "A smart community is a community that has made a conscious effort to use information technology to transform life and work within its region in significant and fundamental rather than incremental ways." The concept of the smart community could better serve the focus of this particular paper, since the main emphasis is on regional development, extending beyond the formal city limits. Chourabi et al. (2012) state that the success of smart city initiatives relies heavily on managerial factors. More and more cities are taking a strategic approach to become smart. However, most of them face the challenge of figuring out the overall entity of becoming smart, how to connect smaller projects with each other, and to steer the progress from end to end.

The research question to frame the case study is: "What strategies can foster beneficial participation and collaboration in smart city open data initiatives?" This study centers around two smart city services: the Tavastia Events smart city service, which provides cities, citizens, organizations, and other users with the opportunity to showcase events and make use of open data generated on the platform, and 'Hämeenlinna in pocket' ('Hämeenlinna taskussa') - a smartphone application that provides citizens with smart services and a platform for digital participation in Häme. Our aim is to describe strategies that can lead to successful smart city open data implementations. We first introduce co-creation and innovation with open data. We then present a case study of two smart city services developed in Häme, and finally discuss and summarize the lessons learned and the managerial implications of the development and implementation of smart city services.

Co-creation and Innovation

Innovation is related to interactive and dynamic co-creation processes with end users, customers, and other potential value network parties (Lusch & Nambisan, 2015). It is seldom a straightforward activity. It can be characterized as uncertain, co-constructive, experimental, and interactive (Edvardsson, Tronvoll, & Gruber, 2011; Vargo, Wieland, & Akaka, 2015). Vargo and Lusch (2014) argue that the customer is always a co-creator of value. While attempting to study value co-creation in more detail, the opportunities of applying ICT and data to substantially transform service systems should be taken into account (Edvardsson et al., 2011; Rai & Sambamurthy, 2006). Smart cities provide an environment for user-driven and open innovation (Schaffers et al., 2011), however, co-creation does not emerge itself, but requires active effort from smart city governments (Eden Strategy Institute, 2018). A report investigating a Top 50 list of smart city governments in the world emphasizes that citizens have shown great enthusiasm whey they are given the opportunity to participate in designing and deciding their cities' future (Eden Strategy Institute, 2018).

Creating and Innovating Services with Open Data

Ojo et al. (2015) have studied how open data and smart cities converge. They covered various attempts to co-create digital public services by third parties in their coverage of 18 open data initiatives across five smart cities. Four of the smart cities selected for study were from Europe, namely, Barcelona, Manchester, Amsterdam, and Helsinki. Chicago was chosen to represent the other continents. Conradie et al. (2012)

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argue that, when releasing public sector information through co-creation in the city of Rotterdam, there seemed to be promising collaboration through the co-creation approach. They see the use of co-creation as a platform with the intention to leverage the potential of released public sector information. Relevant partners can create a sustainable infrastructure on this platform to co-create public services. A more open approach to innovation, and real collaboration with stakeholders like end users and external partners make it possible for them to participate in innovation activities. Chesbrough (2003) and West & Lu (2009) argue that a co-creation methodology can be applied to promote stronger interaction with citizens. Also, it can be applied in the design of public services (Hartman et al., 2010).

Lindman et al. (2013) suggest that open data promises an increased availability of data for service development. However, the related research is still emerging, and there are several interesting paths to pursue. Zuiderwijk et al. (2014) identify four essential elements that an open data ecosystem should capture: 1) releasing and publishing open data on the Internet, 2) searching, finding, evaluating, and viewing data and their related licenses, 3) cleansing, analyzing, enriching, combining, linking, and visualizing data, and 4) interpreting and discussing data, and providing feedback to the data provider and other stakeholders.

Ojo et al. (2015) suggest that open data sets supporting tourism are characterized among others by co-created services based on available open data, better information sharing, and open innovation for co-created services. Lindman et al. (2013) propose that open data can be bundled and repackaged as information services that can be provided to customers, citizens, and other stakeholders. Ojo et al. (2015) point out that there are initiatives like "Apps for Amsterdam" and "Helsinki Loves Developers", which aim to enable the co-creation of services addressing the needs of citizens and businesses. These co-created services are based on the availability of open data built applications. Lindman et al. (2013) propose that applying service APIs (Application Programming Interfaces) will provide a more stable platform on which to create and develop new services. They consider many available opportunities for linked, or real time, open data to be redistributed through service APIs.

Toward the Case Study

Ojo et al. (2015) mention that the majority of the studied smart city initiatives were related to governance issues. Among these they list the following: "1) Better information sharing across local authorities through data standards; 2) Improved services across major sectors like transportation and public safety; 3) Enhanced transparency; 4) Co-created services that better address the needs of citizens and businesses; 5) Enabling open innovation in City Administration involving third-party developers; 6) Enhanced inter-operation among a network of cities by sharing tools and methods (standardization); 7) Improved capacities of citizens and stakeholders to leverage open data; 8) Open engagement of citizens in policies; and 9) Significant improvement in internal decision-making".

The case study of this paper involves many of these aspects. The most emphasized issues in the case study are improved services, enabling open innovation involving third-party developers, inter-operation among a network of cities by sharing tools and methods, improved capability of stakeholders and citizens to leverage open data, and co-created services that better address the needs of citizens and event organizers. All in all, this implies that open data related co-creation and service innovation initiatives are multifaceted, and can be approached and studied from various perspectives.

Case Study: Developing Häme Region with Open Data and Open Source

Hämeenlinna is situated in the middle of Southern Finland. Of the five million people living in Finland, over two million have chosen to establish their homes and businesses within radius of 150 kilometers from Hämeenlinna.

Hämeenlinna is a balanced mix of a dense urban environment and a spacious and peaceful countryside, with flourishing rural centres. The most important companies in town are SSAB, Huhtamäki, Patria Vehicles, Konecranes and Kultakeskus. The Hämeenlinna ecosystem program, which started operating in 2019, involves companies, organizations, and citizens. Hämeenlinna has five designated ecosystems: tourism and events, bio-economy, enabling city, renewable industry, and smart services. The ecosystems use information and ICT to improve urban operations, services, and competitiveness. The goal of the ecosystems is to create value for the partners involved via a mutual roadmap. The impact can be shown as environmental, economic, social and communal, or with research and innovation value (Cotton, 2018). Open data assets should be used to provide information supporting analytics and thus drive improved services. Therefore, the creation and usage of

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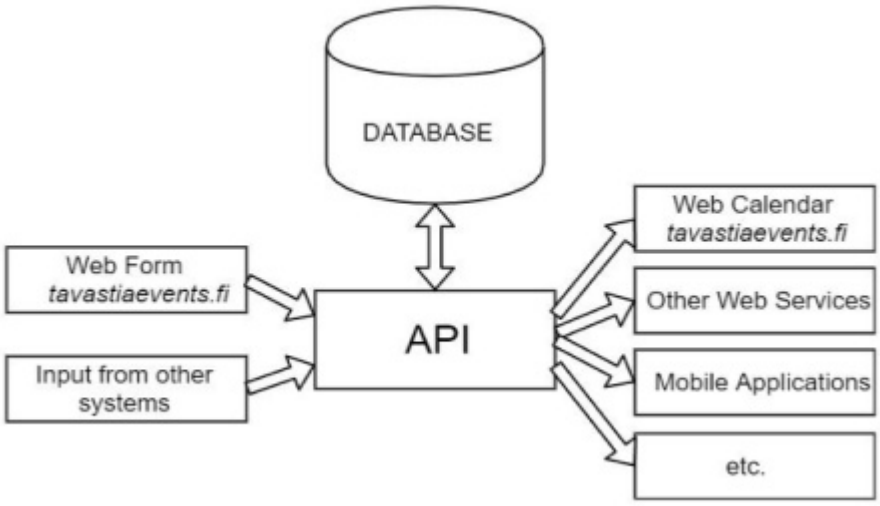

Figure 1. Structure of Tavastia Events API and Web service (Kukkamäki et al., 2019).

open data channels and openness should be included in a city's strategy (Cotton, 2018). The City of Hämeenlinna believes that openness is the key element in every path to future success. This includes for example open data, open meetings, open minds, open innovation, open decision making, open source, etc. This study centers around two projects that support ecosystem development in the Häme region: OpenHäme and Hämeenlinna in pocket.

The OpenHäme (AvoinHäme in Finnish) project was launched in May 2017. The main goal of the project is to develop open data possibilities and capabilities in the Häme region of Finland. In addition, the aim is to increase the amount of open data published in Häme. The project consists of different work packages for creating a collaboration network of different stakeholders, increasing knowledge and skills, and developing pilots to showcase the possibilities of open data. One of the results of the project is the Tavastia Events API.

As early as the application phase of the project, co-creation methods and open participation were used to gather critical information about the expectations of different stakeholders toward the project. Häme Region consists of three sub-regions around three major cities: Hämeenlinna, Riihimäki, and Forssa. In these cities, workshops open to everyone were organized. Especially companies, cities, and societies were invited. In these workshops, all the stakeholders had the opportunity to express all their needs, ideas, and doubts. This information was used when generating the final funding application for the project.

Additionally, in 2017 the City of Hämeenlinna made a strategic decision to provide all the municipal services for citizens in digital form by 2020, requiring rapid progress in practically all areas of smart city development. As part of this strategic goal, the City decided to design and create a smartphone application that provides citizens with the most commonly used digital services and a platform for digital participation. A development project was set up and named "Hämeenlinna in pocket", which was carried out jointly by the City and Häme University of Applied Sciences (HAMK) (Kunttu, 2019). The "Hämeenlinna in pocket" project utilized the development work done in OpenHäme, especially the Tavastia Events API, but also included development of several additional features that were not included in the OpenHäme project.

Tavastia Events API

Tavastia Events is an Event API created for the needs of the Häme region. The API is based on an open source solution called Linked Events (City of Helsinki, 2019), which was originally developed by the City of Helsinki. The modification and implementation of Linked Events for the needs of the Häme region was one of the activities in the OpenHäme project. The web service was developed from scratch to meet the Häme region's needs. From an early stage, Tavastia Events was recognized as the most important concrete development activity in the project. Different stakeholders pointed out the need for this kind of Event API and identified all the possibilities it would offer.

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Tavastia Events consists of two main components, illustrated in Figure 1. The first is an event database and the API (HAMK Smart, 2019) itself, while the second component includes a website (tavastiaevents.fi) to make it easy to input and search for events taking place in the region (Kukkamäki, Jussila, & Mäntyneva, 2019).

The most crucial elements of Tavastia Events are the database and the open API. This is what separates it from traditional web-based event calendars. The API receives inputs from various systems that send machine-readable messages in structured forms and saves them to the event database. In the same way, anyone can fetch event data programmatically from the database through the API and use the data in different ways: in a calendar, mobile application, or any other means they find suitable. This makes it possible for numerous event organizers and users of event information to automate these input and output processes.

This system brings many benefits. In the traditional model, event organizers have to input their events separately in every calendar where they want to gain visibility. This could amount to dozens of different inputs. If the event information changes or the event is cancelled, modifications need to be done again separately to all these calendars. Tavastia Events API makes it possible to gain visibility in multiple channels with only one input, not only in event calendars, but in other applications too. This is also the case when modifying information. Modification done through the API will pass it to every application in real time. This is the benefit of the Tavastia Event API: it gathers all the event information in one place and disseminates it to all the channels that utilize it.

The second major advantage relates to the multiple different stakeholders who use the event data. Cities can easily collect all the events from its area and display them to the citizens. The media, e.g., newspapers, can see at a glance all the interesting events happening and publish news about them. This publication process could even be automated thanks to the machine-readable API and structured format. Companies can also benefit from this data: hotels can tell their guests what is happening nearby, restaurants can prepare special offers, or taxis may reserve sufficient transport capacity. All the necessary information can be fetched and processed automatically.

The above examples already showcase the final advantage. When data is in a structured format, it is easy to create processes around it and handle all the actions in the same way with every event. The data structure is described in Table 1. This also ensures that any critical information such as location or time is present. Tavastia Events has the capability of inputting basic information in English and this supports the possibility to publicize events to tourists.

The API provides the possibility for automatic input or output from/to different existing systems and applications. However, from the point of view of small event organizers, they do not usually have this kind of existing system, and modifying their system would be too expensive. The web form for the manual input of calendar events was developed for this reason. This is a key element to support the usability and accessibility of this kind of service, which is meant to promote all events in the region regardless of the size of event or organizing party. The Tavastia Events website also allows users to search for all the events that are on the website.

Hämeenlinna in Pocket Smartphone Application

Development of the "Hämeenlinna in pocket" smartphone application was based on the use of the Open City Application platform, which provided a framework for the application's software development. In the first version of the application (see snapshot of the application in Figure 2), launched in March 2019, the following features were included (Kunttu, 2019):

Events: The application provides the user with a list of general and public events taking place in Hämeenlinna, including all cultural, educational, and sports-related events. The events can be viewed as a chronological list or located on a city map. The mobile application retrieves the event information from an open data based interface that collects all the event information in the Hämeenlinna area (Kukkamäki et al., 2019).

Topical information and news: The application includes a news channel giving the news, announcements, and information provided by the City. Users have an option to select the information they prefer to receive. The mobile platform can also provide targeted information for citizens based on their own neighborhood. This, in turn, enables collaborative activities and participation at the individual level on matters related to decision making and planning in the citizens' own neighborhood.

Public transportation information: The application contains a route planning tool for public transportation. The user submits the target address and receives a suggested easiest route to the target with bus times. The

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Table 1. Data Structure of Tavastia Events

*Field (*mandatory)*	*Value*
Event	
Event name (fi, en) *	text, 255 characters
Short description (fi, en) *	text, 140 characters
Long description	text, 2000 characters
Event web page (fi, en)	URL
Date and time (single / multiple)*	datetime
Target audience *	text/keyword id
Keywords *	text/keyword id
Paid	y/n
Prices	text, 200 characters
Detailed pricing information	text, 200 characters
Link to ticket shop	URL
Event language *	text/id
External links	URLs
Event organizer(s) *	text, 200 characters
Accessibility	y/n
Picture	file
Owner of picture	text
Admin e-mail *	text
PIN code *	text, 64 characters
Location	
Location name	text, 255 characters
Position (lat/lon) *	WGS84 coordinates
Street address *	text
City *	text
Postal code	text
Detailed information	text

application also reports possible delays or changes in the public transportation system.

Digital library card: The application enables the user to take out a digital library card, which replaces the traditional loan card used in public libraries. The user can install the digital card in the application by logging into the library system through an interface. The user can then use the digital card by showing the barcode from the screen of the mobile phone to the library's user interface (see Figure 2).

My health platform (Oma olo): Through the application interface, the user has access to the digital health portal provided by theCity. The portal provides a variety of instructions for self-diagnosis and care, and also access to consultation with a nurse.

Schedules for free-time sports activities (Liikuntalukkari): The application provides weekly schedules of the free-time after-school sports activities for school-age children organized by the City.

Care-time allocations for nurseries: Through the application interface, parents of small children can book their weekly care-times in nurseries.

Feedback channel: The user can send feedback, questions, or comments to the City authorities through the application. The system classifies the feedback and sends it to the appropriate City authority for further analysis and actions. The user can link the feedback to location information. This is particularly helpful when users report, e.g., faults or problems in their living environment.

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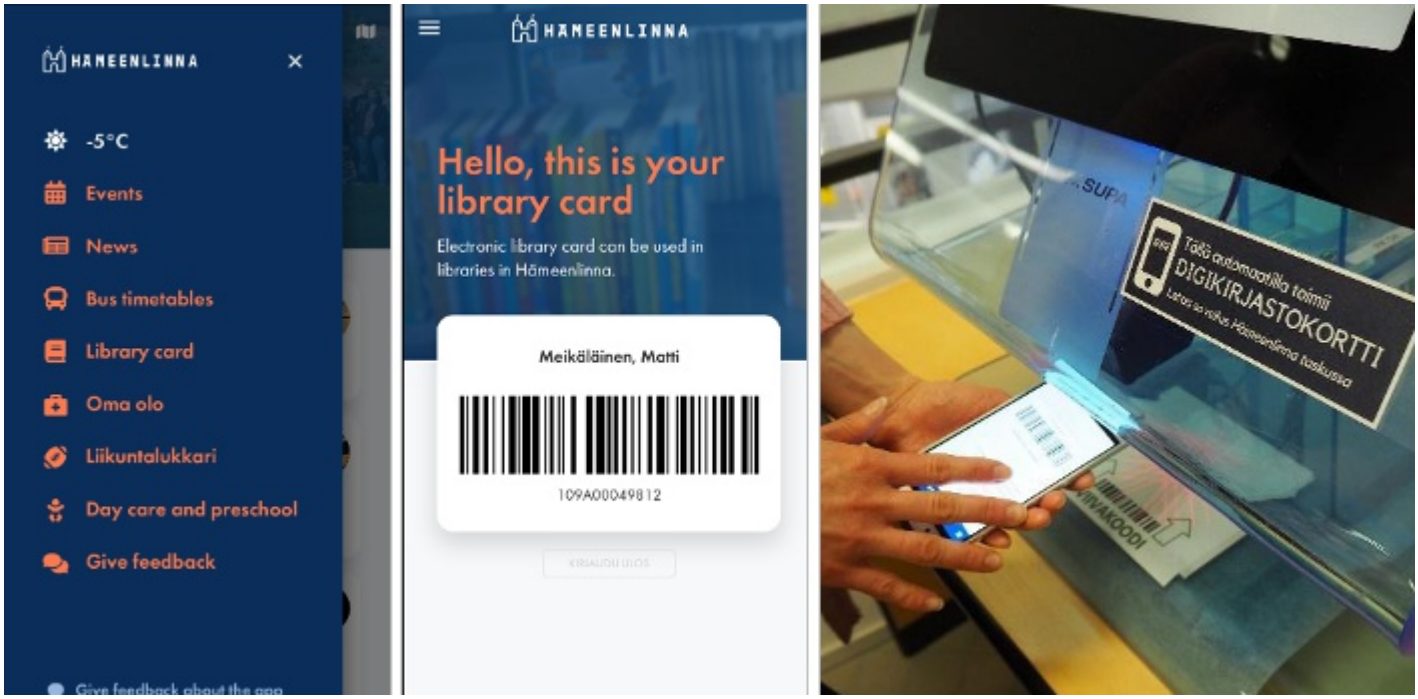

Figure 2. From left to right, the main menu of the mobile application, a snapshot of the digital library card available in the mobile application, and the library card being used on the self-service user interface in the library.

Digital participation tool: The application includes a digital participation tool that allows users to participate in decision making and planning, as part of municipal governance.

Conclusion

Open data that is shared in an effective and open way offers increased possibilities for different stakeholders to innovate together toward shared goals. This case study focused on open data and open source related to events, transportation, and digital libraries in smart city context. Many of the issues raised by Ojo et al. (2015) can be developed through open data, such as improved services, enabling open innovation involving third-party developers, and inter-operation among a network of cities by sharing tools and methods. In addition, the improved capability of companies and citizens in co-creating services is supported.

Making event information available for everyone enables more efficient promotion of regional events for organizers, programmers, and even for private persons. For example, anyone can develop a mobile application to show all the upcoming events and combine them with other information there, such as public transportation, nearby restaurants, or hotel information based on this data. It is obvious that an increased number of different kinds of open APIs would support the formation of new improved services even more. The benefit of expanding on existing open source also highlights the importance of breaking organizational silos, not only inside a city (Ojasalo & Kauppinen, 2018), but also between cities as well. By releasing the developed software code as open source, several cities can take advantage of solutions built for the needs of one city, and thus use resources more smartly. Therefore, whenever evaluating the success of a smart city project, it is recommended to consider replicability and scalability of the smart city project solutions at a wider scale (cf. Bosch et al., 2017).

The first concrete example of a smart city service making use of the Tavastia Events API is the "Hämeenlinna in pocket" application developed jointly by Häme University of Applied Sciences (HAMK) and the City of Hämeenlinna. It offers citizens public transportation information, news, a digital library card, and a list of events occurring in the city (Kunttu, 2019).

From the very beginning it was clear that Tavastia Events would be created to serve the whole region and all stakeholders rather than a single city. It is recognized that some cities in the region have bigger interest than others in Tavastia Events. Still, it is wise to offer services, tools, and methods to everyone, even if the demand is not so high yet. This supports the future development of the whole region and might bring new innovations and

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point out different kinds of needs that would not be recognized in a closed development process. This applies not only to open data, but also to open source code. When the first stakeholders can point out the opportunities and benefits, it usually activates others, too.

The participation of various stakeholders from the early stage of development of Tavastia Events brought many valuable benefits. It is clear that it improved the possibility to gain different insights to be taken into account in development, so there were no unexpected major surprises when it was released. It also committed certain stakeholders to use Tavastia Events instantly after release, as it is crucial for this kind of service to achieve a critical mass of users as fast as possible. Another important observation is that this type of co-creation not only improved the quality of this service, but also committed people to getting together to innovate other solutions that would help to build smarter cities and a smarter region.

Both Tavastia Events event API and "Hämeenlinna in pocket" mobile application have received increasing attention from several stakeholders. It is important to understand the role that open source plays in this development. Even cities, for instance, Helsinki that was ranked 5th place on the top 50 smart city governments (Eden Strategy Institute, 2018), which have been participating in original development of the frameworks are interested about the new and improved features that have been developed in Häme region, extending the original source code. Development has also been noticed in other cities in Finland and source code, experiences and guidance have been shared across Finland by different stakeholders. To get impact from open source or open data, it is important to have channels for open communication, make results visible, and collaborate actively between different parties. Häme University of Applied Sciences, especially it's OpenHäme project has put lot of effort for these activities to promote the possibilities of open technologies.

Experiences and results achieved in these two cases have had impact in development towards a smarter and more open region. Especially, the City of Hämeenlinna has started many activities to improve their capability to benefit from open technologies and to support their usage and development. It takes time before companies are widely ready to implement open technologies in their business. Likewise, it is a long-term process to raise citizen awareness of all the possibilities, even when both services have received positive feedback from companies and citizens. Meanwhile, it is critical to bring out these kinds of showcases, which helps accelerate the penetration of open source to market. The future aim for the Häme region is to support usage of open technologies, update educational curricula, and facilitate knowledge, learning and skills that are required to create new businesses around open technologies.

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Open Data and Open Source Enabling Smart City Development

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