

Open Innovation Opportunities and Business Benefits of Web APIs

A Case Study of Finnish API Providers

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Abstract

APIs aka application programming interfaces have been around as long as there have been software applications, but rapid digitalization of business environment has brought up a new topic of discussion: What is the business value of APIs? This study focuses on innovation and business potential of web APIs. The study reviews existing literature about APIs and introduces concepts including API value chain and different approaches to API strategy. The study also investigates critically the concept of "API Economy" and the relationship between APIs and some current technological trends like mobile computing, Internet of Things and open data. The study employs the theory of open innovation, which was originally conceived by Henry Chesbrough.

The study aims to answer following research questions:

1. What kind of results has open innovation process produced for API providers?
2. What are the realized benefits of API for API provider?
3. What are the main challenges of API management and development?

The empirical part of the study is qualitative case study, which uses semi-structured interviews as a primary data collection method. The study uses multiple case study approach and focuses on six Finnish API providers. The studied organizations include businesses as well as public organizations.

The research findings show that API providers can speed up their product development by leveraging the creativity of third party developers, if they are able to offer them useful and valuable data, which developers can use to solve some practical problems. The results of open innovation (ie inbound open innovation) include applications for new platforms, applications for new use cases, client libraries and shared code, feature ideas and technical improvements. The realized benefits of API include also wider reach of service, business process automation and increased internal agility. The study shows that API providers may use API to foster open innovation, to scale up business, to reach new audiences and to improve internal IT architecture.

In addition the study demonstrates that the theory of open innovation can be applied to the context of web APIs and that APIs can be used to open up innovation process of the organizations as the theory suggests.

Keywords api, web api, api economy, api provider, innovation, open innovation, platform

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List of Acronyms and Abbreviations

API	Application Programming Interface
DX	Developer Experience
EDI	Electronic Data Interchange
IAAS	Infrastructure As Service
IOT	Internet of Things
IP	Intellectual Property
JSON	JavaScript Object Notation
PAAS	Platform As Service
REST	Representational State Transfer
SAAS	Software As Service
SDK	Software Development Kit
SOA	Service Oriented Architecture
SOAP	Simple Object Access Protocol
UX	User Experience
XML	Extensible Markup Language

1 Introduction

APIs aka application programming interfaces have been around as long as there have been software applications, but rapid digitalization of business environment has brought up a new topic of discussion: What is the business value of APIs? Besides technologists also the major business magazines have picked up the subject in recent years. “Are You Using APIs to Gain Competitive Advantage?” asks Harvard Business Review (Iyer & Subramaniam, 2015) and “Welcome To The API Economy” blares Forbes (Medrano, 2012). At the forefront of so-called API Economy are companies like Facebook, Alibaba, and Paypal, which use APIs to transform their products into platforms as Harvard Business Review reports.

“API Economy” might sound like just another buzzword used by its consultants, but closer look on the subject reveals the important role APIs play in multiple current technological developments. APIs alone don’t do much, but they can be seen as important enablers in current developments including cloud computing, Software as Service, Open Data, Internet of Things, mobile computing and platformization. Relationship of APIs and above-mentioned trends will be investigated closer later, but existence of relationships hints that APIs are an important factor in current technology landscape and deserve an in-depth look from a business perspective.

Businesses and public sector organizations are moving forward with APIs in a rapid pace. Today there are multiple examples of so-called API only businesses like Twilio, whose main business is to provide APIs for external developers in order to speed up software development process by making it easier to connect to some other systems. Also older players are experimenting with APIs. For example, retail giant Walmart has released a beta version of API, which opens its product catalog for programmatic access. (Walmart, 2016) Walmart API also allows its partners to earn affiliate revenues from customer referrals. This kind of experimentation with digital business models might be very critical to Walmart, because its rival Amazon is known as one of the biggest most advanced users of API technology. Walmart cannot afford to fall behind. In Finland Helsinki Transport Authority (HSL) has developed its public APIs since 2009 and tapped on the creativity of external developers successfully. Today there is an active developer community around dev.hsl.fi website and dozens of different mobile applications for multiple platforms built on APIs provided by HSL. (Partanen, 2012)

As previous examples illustrate it is possible to use API as a tool to involve partners, customers and outsiders into product development and innovation process. Due to this APIs can be investigated also from open innovation perspective. Open innovation thinking emphasizes that *“Innovators must integrate their ideas, expertise and skills with those of others outside the organization to deliver the result to the marketplace, using the most effective means possible.”* (Chesbrough, 2003) In essence open innovation thinking claims that focusing on internal research and development projects isn't anymore enough, but organizations must be able to take advantage of external ideas and talent. This study will build on open innovation thinking and investigate what kind of innovation possibilities could APIs enable.

1.1 Research Objectives

The objective of this study is to investigate potential of APIs from API provider's perspective. The study will focus especially innovation potential of APIs, benefits of APIs and the challenges API providers face when they try to realize the potential of APIs. The study takes into the consideration the value of APIs for businesses as well as the value of APIs for public organizations. The empirical part of the study includes both businesses and public organizations. The study focuses on business, innovation and cultural aspects of APIs. Issues related to technical implementation of APIs are not in the scope of the study.

Business and innovation potential of APIs is valuable but challenging topic for research. During the research process it has become apparent that relatively little academic research has been done on the topic earlier. Most of the earlier studies like (Espinha et al, 2015) have focused on technical aspects of APIs or related developments like Open Data. (Kinnari, 2013; Lee, Almirall & Wareham, 2016) Very few studies have investigated the APIs from business perspective.

Due to sparseness of prior research and due to fact that APIs are still fairly young and unexplored phenomenon the research also makes use of selected online sources and technology oriented books in order to build understanding of the issue. The study is exploratory in nature and aims to find some promising prospects for further research.

1.2 Research Questions & Methods

The empirical part of the study is qualitative in nature and aims to provide detailed knowledge about APIs as open innovation tool, benefits of APIs from API providers'

perspective and challenges organizations face during their API efforts. The study uses case study approach to focus on six API providers. Semi-structured interviews are used as primary data collection method, because the method provides flexibility, which is required when topic of the research is fairly new and little studied phenomenon such as APIs. In addition study uses various online sources as background material in case analysis.

Main research questions of the study are the following:

1. What kind of results has open innovation process produced for API providers?

The question builds on the concept of open innovation (Chesbrough, 2003), which is investigated in detail in section three. It aims to find out what kind of concrete outcomes has open innovation process produced for organizations, which have used APIs as a tool to foster open innovation and engage third party developers.

2. What are the realized benefits of API for API provider?

This question aims to find out what are the overall benefits of API from API provider's perspective. Depending on the business environment API can be used among other things to foster open innovation, increase reach of service, automatize business processes with partners or create new revenue sources. Potential benefits of API will be investigated closer in the literary review section of the study. Benefits related to open innovation will be excluded from the analysis of this research question, because they will be analyzed in connection with first research question.

3. What are the main challenges of API management and development?

This question investigates what kind of challenges do organizations face in their API efforts, when they are trying to realize the opportunities provided by APIs. The challenges might be business related, cultural or technological.

1.3 Structure of Thesis

The second section of the study gives an overview of API related concepts. The section approaches APIs from business perspective and focuses on the role of API provider. The section provides definition for terms "API" and "web API". In addition it introduces concepts of API value chain and API strategy. It also investigates critically emergent buzzword "API economy" and relationship between APIs and some other current technological developments like open data.

The third section introduces the concept of open innovation in detail. It builds on the works of Henry Chesbrough, the main proponent of the open innovation thinking. The section examines differences between closed innovation and open innovation models. It also examines benefits of open innovation and the concept of platform. Finally the section introduces the research framework, which summarizes most important concepts presented in the literary review part of the study and acts as a theoretical foundation of the empirical part of the study.

The fourth section presents the methodology used in empirical part of the study. The section documents the research process and justifies the choices made during the research process.

The fifth section presents brief descriptions of studied cases and the findings related to research questions defined in the introduction. The section also compares findings to relevant earlier studies and theories presented in literary review section.

The sixth and final section presents conclusions of the research findings. It also estimates study's implications for the theory and the practice and charts some possibilities for further research.

2 Literature on APIs

This section outlines basic concepts associated to APIs. First the definition of the term API in the context of this study is discussed. After that historic background of APIs, main elements of API value chain, available API strategies and business value of APIs are investigated. Also economic importance of APIs and relationship to some other current technology trends like Software as Service, mobile computing, Open Data and microservices architecture is discussed.

2.1 Definition of API

API stands for application programming interface. In technical sense API is set of requirements, which define how one application or software component can communicate to other (Proffitt, 2013). API exposes some of application's internal functions to outside world through clearly defined interface. This way outside world can make use of the functionality without knowing how the internals of the application work. For example mobile applications can use fairly straightforward API provided by phone's operating system to determine location of the phone or to control phone's camera. In essence API can be seen as a contract, which defines how two applications communicate with each other (Jacobson et al, 2012, pp. 4). When contract is in place and documented, communication between API provider and API consumer is efficient because rules of the interaction are clear.

However, this study will focus mostly on certain type of API, which is usually called web API or web service. The study uses same definition of the term web API as Espinha, Zaidman and Gross (2015). Web APIs are accessed over Internet mostly using HTTP protocol and interactions with API follow rules defined by SOAP protocol or architectural style called REST. Web APIs return machine-readable data usually in XML or JSON format. Normal use case for the web API is to make web application's data and functionality programmatically accessible for external applications. In business context web API can be used to make data produced in one unit available to all units, selected partners or totally public. Good example of web API is Twitter's API, which among other actions allows external developers programmatically insert tweets to user's timeline and read latest tweets from user's timeline. The API has made it possible to develop multiple different Twitter mobile and desktop apps like Tweetdeck, Tweetbot and Twittrific. The apps offer different user experience and are targeted to different audiences, but use same underlying data through Twitter API.

API Manifesto released by API:Suomi community (2016) describes APIs in a following way: *“While the graphical browser-based user interface, for example suomi.fi, serves the people, APIs provide machine-readable interface for systems and software.”* This is fairly illustrative way to describe the role of API in software application. Finally Lundquist (2012) provides useful metaphor and simplification by referring APIs as *“digital glue”*, which connects different systems and organizations together and creates new businesses, partnerships and applications. This down-to-earth simplification depicts fairly well how APIs are used especially in business-to-business setting to automatize business processes or inside one organization to make data flow from one information system to another.

2.2 Brief History of Web APIs

First web APIs were released in 2000 (Lane, 2012b), but long before that there have been other technologies, which have served similar purposes. One of them is Electronic Data Interchange (EDI), which has existed for more than 30 years and which provides means to exchange trading data like purchase orders, invoices and shipping notices in electronic form between trading partners. (Ford, 2007; Brewer 2013) EDI technology is widely used especially in logistics and retail industries. EDI reduces need for manual work by automatizing the exchange of trading information in business-to-business environment, but might be very costly and complex to implement because of required integrations to back office systems like accounting and enterprise resource planning systems. Also multiple standards and file formats, which can be used to implement EDI process, might complicate the process. Before the spread of Internet EDI messages were transferred using peer-to-peer or value-added networks, but today most of the EDI messages are transferred using standard Internet protocols. Despite the age and due to large investments made in the past EDI is still widely used by big retail and logics companies and their trading partners. (Brewer 2013)

Web scraping is another technology, which is used in somewhat similar use cases as web APIs. Web scraping was popular technology especially in late 1990s and early 2000s before APIs became common. The idea of web scraping is to automatically extract the data from normal web pages by parsing HTML code found from the pages. This involves numerous challenges because normal web pages are targeted to human beings, not machines. The data they contain might be in non-standard format and structure of pages might change without warning. The pages usually also contain lot of superfluous elements in addition to the data of interest. These elements include navigation menus, logos and ads to mention a few.

Despite the challenges web scraping has been used to implement different aggregation services based on data like product information, public transportation timetables or latest news. Web scraping is still widely used technology in cases where data is not available in machine-readable format through API. Web scraping may be against the terms of use in some cases. Web scraping is also employed by companies like Google, which analyze and index web pages for search purposes. For data provider web scraping is a signal, which indicates that somebody is interested in the data and that there might be demand for an API, which would provide the data in more suitable format. In this situation data provider should consider its business goals and decide whether it makes business sense to make data more accessible.

Modern web APIs were born around the time of dot-com bubble in early 2000. Salesforce was one of the first enterprise oriented web applications, which employed business model known today as software as service (SaaS). Salesforce was also first company to release web API in February 2000. The API, which offered machine-readable data in XML format, was part of the product from the beginning. *“Salesforce.com identified that customers needed to share data across their different business applications, and APIs were the way to do this.”* (Lane, 2012b) Another pioneer was e-commerce company eBay, which released its API in November 2000. From the beginning the goal of eBay’s API program was to create partner ecosystem around eBay platform.

Social media companies Facebook and Twitter, which released their APIs originally in mid 2000s, have been among the most visible utilizers of API technology. In early stages of its life Twitter focused tightly on its core service and let third-party companies build different mobile and desktop client applications, which relied Twitter API. Later Twitter acquired some of these apps including Tweetie and Tweetdeck, because it wanted to guarantee high level of user experience by offering first party mobile app (Kincaid, 2010; Empson, 2011). This could be described also as very good example of API enabled open innovation in action. The concept of open innovation will be investigated more closely in later sections of the study. Facebook in turn has released lot of features, which demonstrate how API makes it possible to expand the reach of service to third party web sites. These features include elements like Facebook Like button and Facebook Login, which can be easily integrated into external web sites.

Also Google Maps API launched in 2006, just six months after web application, has been hugely influential (Lane, 2012b). Today Google Maps is basic building block of many

mobile and web applications. ProgrammableWeb (2016a) entry for Google Maps API reveals that already over 2500 mashups, applications, which combine multiple data sources, have been built on Google Maps API. The case Google Maps demonstrates that there is huge demand for fundamental data like maps and satellite images, which few organizations are able to deliver in global scale.

Recently real-time APIs have become increasingly common. Real-time APIs are used to push real-time information like different kind of event notifications and messages to applications utilizing API. Partly real time APIs are made popular by Internet of Things (IoT) applications, which use real-time APIs to communicate often high frequency sensor data. Real-time API might offer data like real time positions of trains or busses, which are very useful information for users of different kinds of mobility apps. Also social media services like Twitter offer currently real-time streaming APIs, which allow applications to observe published Tweets in real-time.

Technology used in APIs has gone through some changes since early 2000s. In early days API providers favored Simple Object Access Protocol (SOAP), which used XML to communicate with clients. At the time big technology companies like Microsoft and IBM supported SOAP, but in practice it was found out to be too bloated and too complicated for most real life use cases. SOAP was designed for enterprise integration purposes, but it didn't work well in the common tasks like serving data to mobile applications. (Ballinger, 2014). Today most web APIs follow more straightforward architectural style called Representational State Transfer (REST), which principles were defined by Roy Fielding in 2000. Modern web API usually communicates with clients using JavaScript Object Notation (JSON) data format, which is more readable and more lightweight compared to previously popular XML data format. Currently there are no standards associated to REST APIs, but Open API Initiative aims to change that standardize the way REST APIs are described. Open API Initiative is supported by Google, PayPal and IBM among others (Open API Initiative, 2016)

REST approach is currently most popular way to implement APIs, but emerging real time APIs might make use of some other technologies and protocols like MQTT, which is an extremely lightweight protocol designed especially for Internet of Things purposes. (Mqtt.org, 2015) The design principles of protocol aim to minimize network bandwidth and device resource requirements while also attempting to ensure reliability and some degree of assurance of delivery. Thanks to these design principles the protocol suits very well for

different kind of Internet of Things use cases, which often include Internet connected sensors and other devices with limited computing capabilities

2.3 Elements of API Value Chain

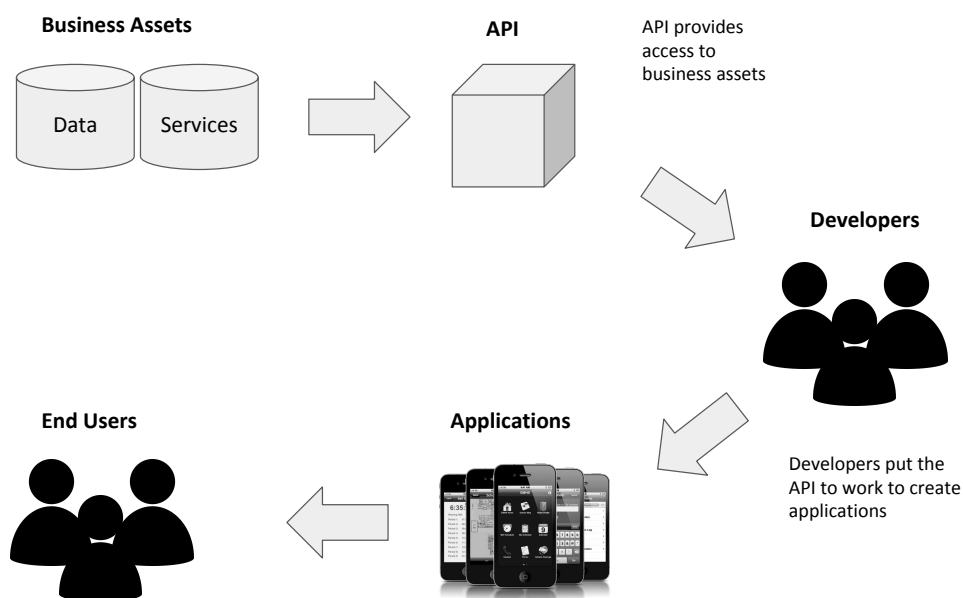


Figure 1: API Value Chain (Jacobson et al, 2011 pp. 22)

When organization is planning and managing API, it should take into consideration the business assets it has, the business goals it is pursuing and the interests of its stakeholders. These elements together form API value chain. The main elements of the value chain are business assets, API provider, developers, applications and end-users. Analysis presented in this section uses API value chain elements recognized by Jacobson et al (2011, pp. 28). Selected strategic approach to API management affects significantly on the nature of interactions in the value chain even though the main elements stay the same. Different approaches to API strategy are investigated later in section 2.4.

2.3.1 Business Assets

Business assets include data and services, which are made accessible by API. Depending on business requirements and selected API strategy assets can be made accessible only to developers within the company, selected partners or globally for everybody. For example, in the case of weather data company Foreca the assets are weather and climate data which company is selling to clients around the world through web API. Thanks to API clients can

consume weather data automatically in their own applications and bring service into use quite fast.

2.3.2 API Provider

API provider is often but not always the same organization as the owner of business assets. API provider is responsible for availability of API. It must allocate sufficiently resources to API design, development and maintenance or outsource those tasks. API provider should document the API so that internal or external developers understand how API works and are able to use it. API provider should also create some kind of incentive, which encourages developers to use the API. In addition API provider can also promote API in order to increase API usage and awareness of API. Some popular methods in this field include organizing hackathon events or hiring developer evangelist to connect better with developers

2.3.3 Developers

Depending on selected API strategy developers using the API might work within the organization, they might work for some strategic partner or their subcontractor, they might be tech-savvy heavy users of the service or they might be just independent developers looking for new challenges. Especially motivations of latter group might vary a lot. Independent developers might be motivated by activism or public service. They might be motivated by technological challenge or they might be looking for a prospect to make money by building successful app on API. Developers are good source of feedback and new ideas. Therefore API provider should be in touch with developers regularly and provide as much support as possible.

2.3.4 Applications

Applications built on API might vary a lot. They might be mobile applications, desktop applications, applications for wearable devices, data visualization tools or integrations to other systems. Access to application might be limited only to a certain company or application might be publicly accessible. A good example of integration application is WordPress-to-lead for Salesforce CRM plugin. It integrates WordPress blogging system and Salesforce CRM in a way that a contact form entered on WordPress site goes straight into Salesforce CRM as a lead.

2.3.5 End-users

End users are the ones who use applications built on API. In business-to-consumer setting they might be customers who download mobile application from mobile application store. In business-to-business setting they might be employees of the partner company. The applications built on API should benefit and create value for end-users.

2.4 API Strategies

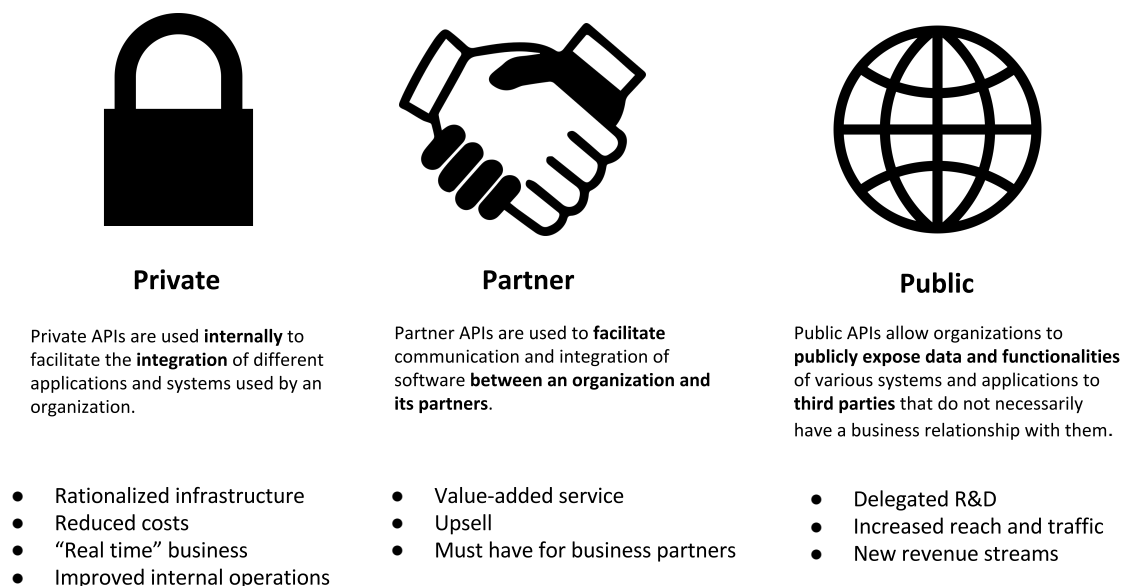


Figure 2 API Strategies (Boyd, 2014)

In most cases it is beneficial for API provider to define primary use case for API. This is one of the most important considerations API provider has to make. API might be targeted for internal use within the business, the main use case of API might be easy integrations with most important partners or the goal might be to make selected data within business publicly accessible for individual developers around the world. Three main approaches to API strategy identified by Boyd (2014 & 2015) are called private, partner and public. Also Willmott (2015) uses very similar classification. Relevant approach depends on the business model of API provider and on the business environment API provider is operating. Technically APIs implemented under these approaches might be exactly the same, but selected approach determines how API provider prioritizes different features and different stakeholders of API.

2.4.1 Private

Private API is targeted to developers working within business. Private API is often used to make some application or dataset accessible within the business so that it can be easily reused in other application or business unit. This way private APIs can be used to break down organizational silos and reduce duplicate processing of information across departments. In addition private APIs can be used as building blocks of microservices architecture, which is more modern and more lightweight variant of older service-oriented architecture approach (Bradbury, 2016). In this approach traditional monolithic business applications are break down into multiple small services that talk to each other through APIs. Microservices promise to bring more speed and agility to software development. Smaller applications are faster to develop and easier to change, because thanks to APIs there are less independencies when compared to old-fashioned monolithic applications.

Private APIs are also often used when there is need to access data through mobile interface like an iPhone or Android app. Many API professionals like Lane (2012a) recommend that organizations should start their experiments with private APIs and move to partner and public APIs when they have gathered required experience of API management and development. Private API approach allows API provider to see problems and challenges associated with APIs, but failures will only affect the API provider itself. One company employing this approach has been Amazon, which teams expose their data and functionality to other teams through API. The approach allows Amazon to stay organized and agile, while there are multiple teams working with different services of its system infrastructure in the same time.

Operations and support require fewer resources in private API approach than in other approaches. API provider should still aim to create high quality API documentation and provide necessary support to developers so that they are able to use the API and realize the opportunities provided by API. The private APIs are usually not publicly documented.

2.4.2 Partner

In partner approach API provider is using API to integrate and automatize interactions with its partners. The approach is popular especially among businesses operating in business-to-business market environment. Well-defined and well-documented API facilitates integration of business processes when new business relationship is being established. The API reduces need for customized system-to-system integrations and makes communication easier when

the interface between partners has been built and documented in advance and implemented using standard technologies.

Partner API makes it also possible to deepen relationship with partners by integrating business processes more tightly and by offering partner real time operational data. Typical use cases for partner API are automated invoicing, ordering and payment systems, product and price catalogs and different kind of status lookups. Partner API approach usually requires more resources than private API approach, because API provider has to support also external developers working for their partners or partners' subcontractors. In partner environment API development has to be conducted in a way that changes and new features do not break existing integrations with partners. The documentation of partner API might be public, but getting access to API usually requires business relationship with API provider.

2.4.3 Public

Public API is publicly documented and accessible to any party that wishes to sign up. In best case public API allows API provider to tap into creativity of countless third party developers. Public API gives API provider an opportunity to transform its product into a platform, which third party developers can extend and incorporate into their own applications. That is one reason why big platform oriented online companies like Facebook, Twitter and Google have invested heavily in API development. Also Software-as-service providers serving small and medium-sized companies usually make it possible to extend their service through public API. Public API approach is also favored by public sector organizations like municipalities, because the data they have is often public in nature and should be made as easily accessible for everybody.

Developing and supporting public API requires more resources from API provider than two earlier approaches. API provider has to provide support for developers who might not be very familiar with his product. According many API professionals like Bortenschlager (2015) developer experience (DX) is one of the most important factors of successful API program especially in the case of public APIs. Term developer experience refers to developer's total experience of working with given API. Developer experience is a sum of things like quality of API documentation, responsiveness of technical support, technical quality of API, ease of getting started with development work and quality of available software development tools for API. Getting developer experience right might require significant investments from API provider. In order to successfully involve third party developers into the product development

process API provider has to have data, which inspires developers or it has to offer other incentives like profit sharing.

2.5 Business Benefits of APIs

APIs can generate value for API provider in various ways. This section investigates the most common benefits of APIs and use cases, which allow API provider to realize those benefits. The presentation combines benefits recognized by Jacobson et al (2011, pp. 24-27 & 29-31), Bortenschlager (2014) and GSA (2016). The focus of the presentation is on the benefits, which are relevant both to business and to public organizations.

2.5.1 Wider Reach of Service

Partner and public APIs allow partners and third party developers to create applications for various platforms and for various use cases. These applications help API provider to reach new audiences without investments into in-house application development (Jacobson et al, 2011, pp. 30). Well-designed and documented API speeds up also in-house application development and makes it easier to build applications for new channels.

In addition APIs can be used to create various user interface elements, which can be easily integrated into other services. Good examples of this kind of widgets are Facebook Like button and Google Maps widget, which increase reach of Facebook and Google Maps to countless third party web sites. API also increases reach of service by making data more accessible to different aggregation services, which combine data from multiple sources. Examples of such services include various price comparison, product comparison, event listing or news aggregation services.

2.5.2 Increased Agility

Within boundaries of one organization APIs can expose previously closed data sets to the entire organization as described earlier in the section about API strategy. This helps to breakdown organizational silos, eases co-operation between different units and increases agility of organization. APIs make it possible to share financial, sales, analytics, warehouse or some other type of data within the organization and quickly build applications on top of that data.

In addition APIs can be used to encapsulate organizations most important IT capabilities into small, independent applications, which are accessible to the entire organization. This kind of approach to IT architecture is usually know as service-oriented or

microservices architecture (Bradbury, 2016). In these architectures organization's IT capabilities are created by multiple modular services instead of one monolithic information system. The architecture is future-proof and agile, because it is possible to update services one by one, add new services when needed, implement individual services using most suitable technology and maintain clear separation between different layers of system like business logic and user interface. Usually there is no need to renew entire information system at once, which is notoriously challenging and disruptive for most organizations.

2.5.3 New Revenue Sources

API might be a new source of revenue for API provider. One option is make the consumer of API to pay for API access, if that is reasonable given API provider's overall business strategy and nature of data and services provided through API.

Musser (2013) divides these "developer pays" revenue models into following five categories; pay as you go, tiered, freemium, unit-based and transaction fee. In "pay as you go" model API consumer pays only for the resources they actually consume. In "tiered" model API consumer pays for a particular usage tier based on the number API calls over a fixed time period. In "freemium" model API provider offers some of the API capabilities for free and then charges for additional functionality. In "unit-based" model consumed units of measure, such as API calls, determine pricing. "Transaction fee" model is used by many online payment providers. In the model pricing is dependent upon the value of the transaction.

2.5.4 Business Process Automation

Especially in business-to-business setting and under partner API approach business process automation between business partners is an area where API can be very beneficial. APIs make it easier to automatically export and import data between different information systems. APIs allow machines to handle workloads, which would otherwise require the manual work of humans (GSA, 2016). These workloads might include various regular scheduled batch-processing tasks, which transfer data between business partners.

In addition well-designed, well-documented and standardized API may speed up customer onboarding in cases where customer relationship requires integrations between information systems of service provider and customer. API makes integrations faster to implement and allows service provider to scale up its integration capabilities (Jacobson et al, 2011, pp. 17). In same way APIs also help business development and make it easier to

experiment with different kind of digital partnerships, which might require integrations between information systems.

2.5.5 Fostering Innovation

APIs speed up internal and external innovation by opening new data sources and services to new user groups and by lowering organizational boundaries in the process. APIs also speed up application development and make it easier to experiment with different platforms, user interface concepts and use cases. Depending on the selected API strategy API provider might decide to incorporate into innovation process in-house developers, developers working within same business network or all developers who show interest toward API provider’s service. API provider may facilitate innovation by organizing API focused events like hackathons or app competitions. In addition API provider might offer developers financial incentives like revenue sharing. Section 3 investigates relationship between web APIs and open innovation in more detail.

2.6 API Economy

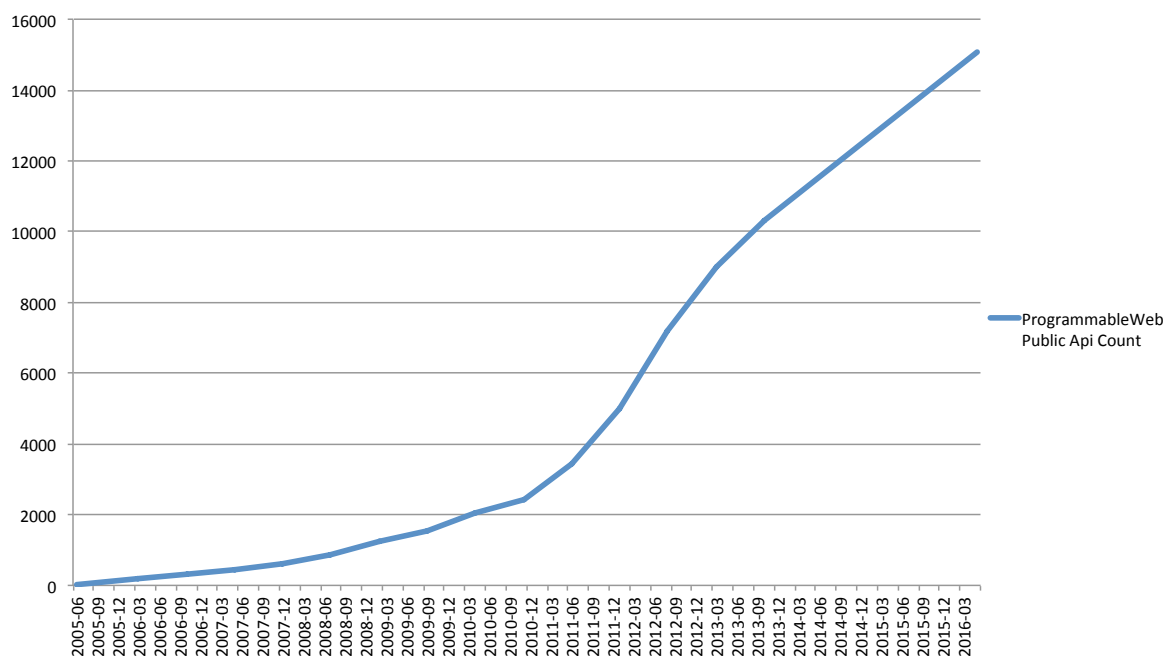


Figure 3: Growth of public APIs between 2005 and 2016 (ProgrammableWeb, 2016b)

In recent times the term “API economy” has surfaced in connection with APIs. The term is popular especially among the proponents of API technology. There is no established definition of API economy, but the term is usually understood to refer to increased economic significance of APIs. In an article titled “Welcome To The API Economy” Medrano (2012)

predicts that very soon APIs will become “*a primary customer interface for technology-driven products and services and a key channel for driving revenue and brand engagement*”. API Manifesto released by API:Suomi community states that in API economy APIs are raised at the center of digital operations and are seen as a way to serve the needs of different stakeholders as efficiently as possible. Manifesto also stresses that APIs change existing business models and help business ecosystems scale effectively. (API:Suomi Community, 2016)

Commonly used yardstick for the growth of API usage is count of APIs listed in API directory ProgrammableWeb. First APIs were added to the directory in June 2005. In October 2013 directory listed already 10302 APIs (ProgrammableWeb, 2016b). In May 2016 there are over 15000 APIs listed in directory. APIs listed in ProgrammableWeb are all publicly documented. Increase in the number of public APIs has been rapid, but many API professionals believe that public APIs are only “*tip of a ice berg*”. In addition there are countless APIs, which are not publicly documented and used only internally by API provider or by selected partners of API provider. (DuVander, 2011) These APIs are not as visible as public APIs, but they play important role in digital transformation of businesses by exposing previously inaccessible data sets and services to new users within business or its stakeholders. Things like showing real time inventory level for product in online store or retail store are made possible by internally used APIs.

In the light of earlier research the concept of API economy resembles a lot concept of network economy. According to Möller (2006) network economy is defined by following characteristics: “*Business networks are replacing traditional markets and vertically-integrated companies. Global competition is pushing companies to focus on their core competencies. IT is lowering transaction costs and providing tools to manage increasingly complex inter-company collaboration. Empowered by new digital media, network organizations are expected to take a lead in creating economic and social innovations.*” The characteristics apply fairly accurately also to API economy. In API economy APIs are the connectors, which bind the nodes of business network together and ensure that data flows smoothly through network. APIs push transaction costs even lower and automatize inter-company collaboration. In this sense term “API economy” is just a new variation of network economy, which can be used to highlight the role of APIs.

While businesses and public sector organizations are experimenting with opportunities of APIs, they are very current topic also in business and technology community. Most visible

advocate of APIs is probably aforementioned web site ProgrammableWeb, which maintains directory of open APIs and publishes API focused news reporting and research. In Nordic level web site Nordic APIs increases API awareness in technology community and in Finnish level API:Suomi works toward similar goals.

2.6.1 The role of APIs in current technology landscape

One way to estimate the significance of APIs as a technology is to investigate the role APIs play in other current technological developments. APIs can be seen important enablers at least in following technology trends: Software as service (SaaS), cloud computing, mobile computing.

API is important part of value proposition of typical SaaS product, especially in business-to-business setting. This is highlighted by the fact, that first modern web API was introduced by Salesforce, a SaaS provider in 2000. (Lane, 2012b) API provides especially business users means to integrate their other information systems with SaaS application. When software was hosted on local servers, it was often possible to install add-ons, customize configuration or manipulate data in database directly, but in case of SaaS application this is usually impossible, because application is hosted and maintained by SaaS provider. In case of SaaS applications this kind of integration and customization needs are implemented using API. Due to this it is important that SaaS application offers comprehensive and easy-to-use API for its clients. Often API is a mandatory requirement, when business is selecting SaaS provider. API might also offer upselling possibilities for SaaS provider. For example, Salesforce enables API access only for customers who have purchased higher priced premium subscription.

APIs play important role also in cloud computing, where they are used to automatize tasks like provisioning of new server instances. The automation increases efficiency of server administration, decreases need for human work and allows cloud-based services to scale more efficiently according to demand. Infrastructure as service (IaaS) and platform as service (PaaS) providers like Amazon Web Services, DigitalOcean or Rackspace offer very developed APIs to their platforms. The APIs can be used to automatize most of the same tasks, which can be performed manually using their web-based administration user interfaces.

Relationship between APIs and mobile computing is very close knit. Need for mobile application often creates also need for an API, if organization doesn't have one already. This is due to the fact that native mobile clients like iPhone and Android applications

communicate with back-end server through API. Well-designed and well-documented API eases communication with mobile app developers and speeds up development of mobile apps. Well-designed API is also flexible enough and makes it also possible to development multiple different client applications like tablet apps, smart phone apps or smart watch apps, which communicate with back-end system through the same API. Currently many companies follow so-called mobile-first or mobile-only strategies, which means that they launch their service first and maybe only as a mobile app following example of Uber, WhatsApp and many others. In this case API is most likely at the center of their operations from the beginning. These days also web user interfaces might communicate with back-end systems through API. This offers possibility to improve architecture of information system by making clear distinction between user interface layer and back-end systems.

2.7 APIs & Open Data

The role of API in open data setting is to make data set more accessible by providing programmatic access to data. Well-designed API eases further processing of the data, makes it easy to integrate the data source with other information systems and makes it is easy to build applications, which utilize the data. If there is no API, developers have to duplicate data and build their own backend systems, which serve data to client applications. This of course slows down utilization of open data. This chapter introduces the concept of open data briefly and presents some earlier open data related research. Open data is relevant concept from the perspective of the study, because empirical part of the study includes some public sector organizations, which provide also open data.

Open Data Foundation (2016) defines open data in a following way: “*Open data is data that can be freely used, re-used and redistributed by anyone - subject only, at most, to the requirement to attribute and sharealike.*” Objectives of open data include increased transparency and democratic control, increased participation, increased innovation and improved efficiency of government services. Most of the open data is produced by public sector organizations. According to law this data is public by default, but open data movement aims to make it accessible also in practice. Open data started to become visible in the mainstream around 2009, when various governments including USA, UK, Canada and New Zealand announced new initiatives towards opening up their public information. (Open Data Foundation, 2016) Today significant open data sources include data.gov, which publishes open data produced by US government and data.gov.uk, which publishes open data open data

produced by UK government. In Finland notable open data sources include sites like avoindata.fi and Helsinki Region Infoshare (hri.fi).

There has been lot of interest especially towards applications and businesses built on open data. The applications, which process and visualize the data, are needed to make the benefits of open data tangible for an ordinary citizen, because raw open data is not very useful for casual users. In addition governments around the world maintain hope that opening of data reserves gives raise to new breed of startups, which base their business on open data. For example, in Finland Open Finland Challenge competition, formerly known as Apps4Finland, has been organized already seven times by Open Knowledge Finland association. The competition challenges participants to create applications, which solve everyday problems by utilizing open data in a new way. An example of an app produced by competition is Stormwind Simulator, 3D boating simulator running on Windows and based on open map data provided by National Land Survey Finland. The simulator won Apps4Finland competition in 2013. (Forum Virium, 2013)

Recently services built on open data have also been in the focus of information system research. In 2013 Lindman, Rossi & Tuunainen plotted research agenda for open data services. They identified research gap in our understanding of open data services and defined seven areas, which upcoming studies could focus on. The focus areas they defined were following: 1. *Technologies* 2. *Information* 3. *Processes and activities* 4. *Products and Services* 5. *Participants (including developers, data owners, and service developers)* 6. *Customers* 7. *Environment*. This study touches on the research agenda, because the empirical part of the study investigates open innovation potential and benefits of APIs from data owners' point of view. However, this study is not limited to open data owners. It includes also businesses, which provide non-open data through their APIs.

Kinnari (2013) studied open data business models in Finnish media industry. The study identified five types of businesses, which have built their business on open data: 1. *Data analysers* 2. *Data extractors and transformers* 3. *User experience providers* 4. *Commercial data publishers* 5. *Support services and consultancies*. The study concluded that the open data industry in Finland is still in its infancy, but identified also some promising commercial successes. This study also touches on Kinnari's study, because the case organizations in the empirical part of the study include some API providers, which provide data to businesses studied by Kinnari.

Lee, Almirall & Wareham (2016) studied apps produced as a result of open data application competitions like Open Finland Challenge. They found out that first generation apps did not produce measurable civic benefit. They found out multiple problems associated with these apps. Developers with similar interests and demographic backgrounds produced lot of similar apps, which were focused on same topics like transportation and mobility and used mostly same data sets. In addition adoption and support by governments was found out to be limited. However, they found out that these problems were taken into consideration, when new second generation apps were planned. Now problem statements published by data provider are used to direct developer attention toward significant problems. Now developers are also embedded in public organizations for longer time periods in order to better understand problems faced by the organizations. This study investigates also impact and role of apps enabled by public APIs, but focuses more on the perspective of the data provider.

3 Literature on Open Innovation

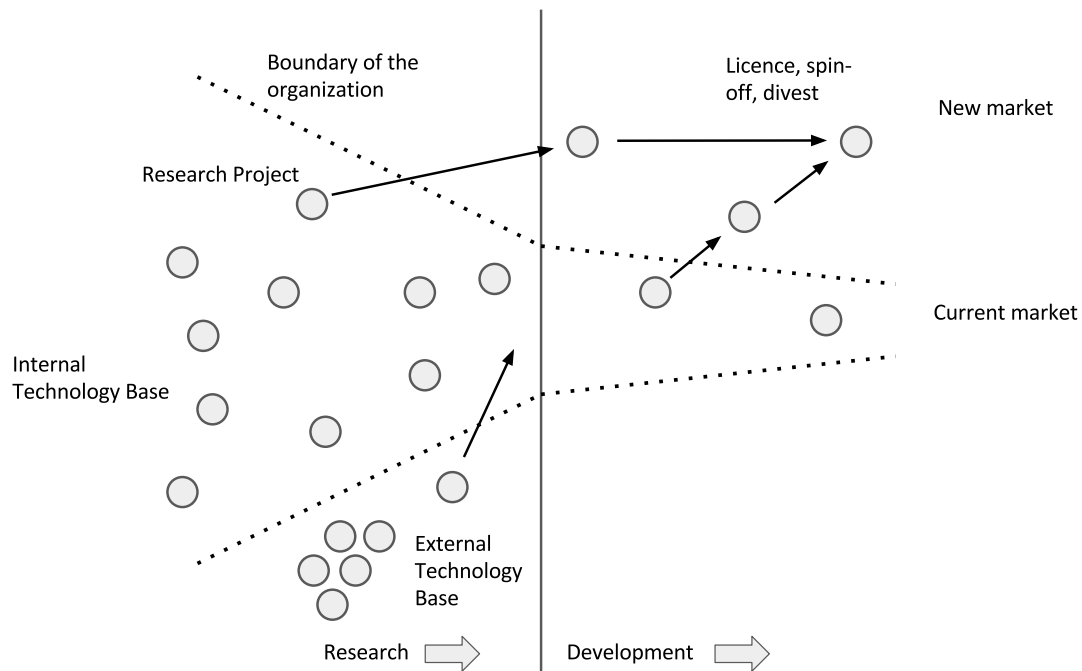


Figure 4: Open innovation model (Chesbrough, 2003)

Open innovation paradigm has attracted lot of attention from researchers during recent years. This section presents fundamental concepts of open innovation and shows how open innovation can be applied to the context of APIs. The section also examines benefits of open innovation and major differences between closed and open innovation models. Finally the section investigates concept of platform and investigates how open innovation thinking and technologies like APIs can be used to transform products to platforms.

The concept of open innovation was introduced in 2003 by professor Henry Chesbrough in his book *“Open Innovation: The new imperative for creating and profiting from technology”*. Since then the concept has been studied a lot and applied often especially in areas like research and development in technology industry and open source software development.

Chesbrough sums up the open innovation in following way: *“Open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. Open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market.”* (Chesbrough et al, 2006)

The open innovation was originally based on Chesbrough's observations of technology industry. He noticed that some technology companies like Cisco were able to succeed and bring new products to market, although they invested fewer resources into their internal research and development efforts than their competitors. Chesbrough noticed that Cisco leveraged external knowledge very effectively. When the company needed new technology it acquired it by partnering or investing promising startup companies. This allowed Cisco to keep up with competitors who had much stronger internal R&D organizations. (Chesbrough, 2003)

In the heart of the open innovation are inbound and outbound knowledge flows (Chesbrough & Crowther, 2006). The inbound flow refers to the practice of leveraging the discoveries of others. These practices include partnerships, acquisitions and collaborations with different stakeholders. The use of publicly available knowledge like open source software is also one potential inbound flow. (Riepula, 2015, pp. 47) The outbound flow refers to practices in which internal ideas and resources are brought to market using external organizations and partners, i.e. external paths to market. These practices include licensing, open sourcing, corporate spin-offs, alliances and collaborations.

Effective use of inbound and outbound flows of knowledge is potentially significant source of competitive advantage for the company. The knowledge flows also blur boundaries of organizations considerably, which is one significant characteristic of open innovation model.

3.1 Closed Innovation Versus Open Innovation Model

Closed innovation model can be described as a closed funnel in which some of the internal research projects started by the company end up as new products after a careful vetting process (Chesbrough, 2003). The closed innovation process is based on company's internal research and development capabilities and other internal knowledge. Boundaries between organizations are very clear. The closed innovation model requires that the company invests heavily into research and development efforts and hires best people in order to ensure steady flow of new products. According to Chesbrough (2003) the closed innovation model has been considered historically as a "right way" to do the product development and most large corporations like General Electric, IBM, DuPont and AT&T have relied on it. Big research centers built by these companies demonstrate how closed innovation model is usually implemented in practice.

In open innovation model, on the other hand companies make extensive use of external knowledge and they may also bring their products to market by using external paths to market as described earlier. In a way open innovation model is based on realization that company cannot hire all the brightest people these days and that there is lot of useful knowledge outside of company. Significance of open innovation approach has increased in recent decades and according to Chesbrough (2003) there are two main factors, which explain this change. Firstly, increased mobility of knowledge workers has made it increasingly difficult for companies to control their proprietary ideas and expertise. Secondly, the growing availability of venture capital has helped to finance new firms and new efforts to commercialize ideas that have spilled outside the silos of corporate research labs. Following table summarizes the differences between two innovation modes.

Closed Innovation Principles	Open Innovation Principles
Most of the smart people in our field work for us.	Not all the smart people work for us, so we must find and tap into the knowledge and expertise of bright individuals outside our company.
To profit from R&D, we must discover, develop and ship ourselves.	External R&D can create significant value. Internal R&D is needed to claim some portion of that value.
If we discover it, we will get it to market first.	We don't have to originate the research in order to profit from it.
If we are the 1st to commercialize we will win.	Building a better business model is better than getting to market first.
If we create the most and the best ideas in the industry, we will win.	If we make the best use of internal and external ideas, we will win.
We should control our intellectual property (IP) so that our competitors don't profit from our ideas.	We should profit from others' use of our IP, and we should buy others' IP whenever it advances our own business model.

Table 1: Comparison of innovation models (Chesbrough, 2003)

As Chesbrough's (2003) comparison between Lucent and Cisco demonstrates, open innovation approach is often more cost efficient and less capital intensive than closed innovation approach, because open innovation doesn't require big internal research and development capabilities. Due to this open innovation approach is very suitable for tough economic times when maximizing output of research and development efforts while keeping fixed costs in check is crucial for companies. By employing open innovation creatively businesses can keep innovating without spending lot of money as Chesbrough and Garman (2009) suggest. In their article they introduce strategic moves, which employ especially outbound open innovation and help businesses keep their innovation capabilities up without big cost increases. The proposed moves include following. Joint ventures and corporate spin-

offs are options to create new capabilities by employing external knowledge and financing, if a business does not have enough internal resources. The business can then become customer of this new entity. Businesses can also let others develop their nonstrategic indicatives by spinning them out to external investors or by opening up their business model and allowing external parties to extend their product. In addition businesses can take advantage of practices like licensing to monetize their existing intellectual property (IP). Later, the empirical part of the study presents, how some of the analyzed case organizations are employing these approaches.

3.2 From Products To Platforms

The concept of platform is closely associated to open innovation, because platforms are important enablers of open innovation. Zhu and Furr (2016) define platform as intermediary that connects two or more distinct groups of users and enable their direct interaction. Some of the most visible examples of platforms are mobile operating systems like Apple's iOS and Google's Android, which connect mobile users and third party application developers. The applications built by third party developers increase value of core product, mobile phone, considerably. Mobile platform providers use methods like software development kits and new distribution channels, application stores, to open their products to open innovation and to foster open innovation process.

Many businesses seek to turn their products to platforms, because products usually generate single revenue stream while platforms can generate many (Zhu & Furr, 2016). For example, Apple receives revenue from buyers of iPhone and from developers selling paid applications in App Store. In addition many platforms are two-sided markets and benefit from two-sided network effect (Voigt & Hinz, 2015). This means that an increased usage by one user group increases platform's value to complimentary user group and vice versa. For example, the more there are third party application developers working with iPhone applications, the more valuable the platform is for mobile phone users. This means that user activity and open innovation taking place on the platform are important sources of competitive advantage for platform providers like Apple. Network effects protect their position once it is established and users rarely leave a vibrant platform (Edelman, 2015). Building successful platforms is challenging because critical mass of users is often required before platform is useful to anybody (Boncheck & Choudary, 20013).

3.3 APIs and Open Innovation

According to Boncheck and Choudary (2013) successful platform strategy is defined by three factors, which they call connection, gravity and flow. *“Connection: how easily others can plug into the platform to share and transact. Gravity: how well the platform attracts participants, both producers and consumers. Flow: how well the platform fosters the exchange and co-creation of value.”*

Web APIs, which are in the focus of this study, can be used to implement first factor mentioned by Boncheck and Choudary. API allows external developers to plug into API provider’s business assets and build new applications on top of those assets. Things like design of API, technical quality of API and quality of API documentation greatly affect how easy the process is. API is important building block, if organization wants to turn its web or mobile-based product into a platform. So-called gravity of the platform depends largely on the nature of business assets. If the assets are valuable and useful to large enough group of users, prospects of the platform are good. In addition API provider’s business model and possible financial incentives offered to third party developers also affect the gravity of platform.

By exposing business assets to external developers API also facilitates open innovation. In open innovation sense data and services exposed by API form the outbound flow of information (Aitamurto & Lewis, 2011). This flow makes it possible to build new applications and products outside of API provider’s organization. The flow also enables external paths to market. The third party developer might find new ways to commercialize data and services provided through API. Third party applications provide new ideas for API provider and ease internal product development. This is the inbound flow of open innovation (Aitamurto & Lewis, 2011). The API provider might also acquire or hire successful third party application developers. The actions of Twitter, which were presented earlier, demonstrate these flows nicely. First Twitter took advantage of outbound open innovation by opening its API to third party developers whom built various Twitter mobile applications. After a while Twitter took advantage of inbound open innovation by acquiring some of the third party application developers and using their applications as basis of in-house Twitter mobile application (Kincaid, 2010; Empson, 2011).

Aitamurto and Lewis (2011) have studied open innovation around APIs provided by US media organizations. They found out that news organizations have benefited from open

innovation in various ways. It has sped up their research and development initiatives, helped to reach new audiences and helped to serve better some niche audiences. They observe that APIs have not yet been transformational to news organizations, but their findings point toward platform oriented business model in which value and revenue are co-created with collaborators in a variety of ways. The study by Aitamurto and Lewis is one of the few previous studies focusing on the business or the innovation aspects of APIs.

3.4 Research Framework

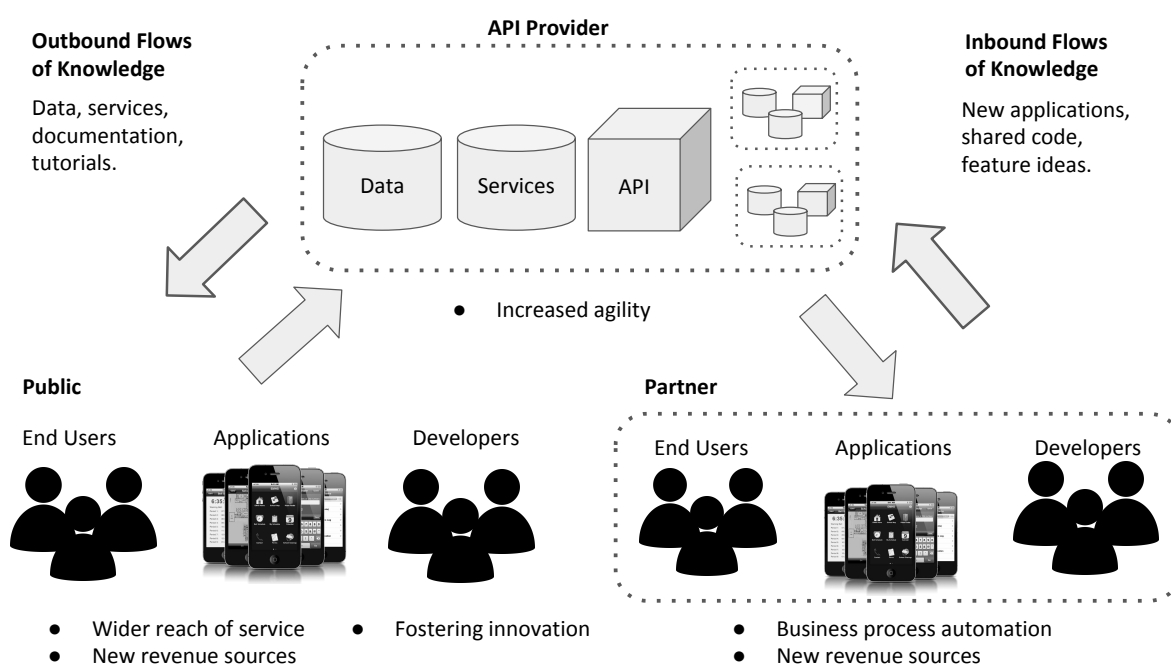


Figure 5: Research Framework

The above figure summarizes the main concepts of the literary review part and introduces the research framework, which acts as a conceptual foundation of the empirical part of the study. The framework combines ideas from API and open innovation literature.

The framework presents outbound and inbound flows of knowledge between API provider and its stakeholders. In addition framework presents different elements of API value chain and business benefits, which API provider may pursue employing the available API strategies. The empirical part of the study analyzes how do API providers utilize and facilitate these knowledge flows, how do they approach API strategy selection, how do they prioritize potential benefits and how do they take into account different elements of API value chain. All the elements of the framework are presented in detail earlier in the literary review part of the study.

4 Research Methodology and Data

The empirical part of the study is qualitative case study, which uses semi-structured interviews as a primary data collection method. Theories and concepts presented in literature review part of the study were used as a theoretical framework when research questions and interview themes were designed. Six organizations were analyzed in order to answer research questions defined earlier. This section describes the research approach and method used in the study. The section also justifies the choices made. It also documents research process including interview theme design, case selection, data collection and data analysis.

4.1 Research Approach

The study employs qualitative research approach, because it's aim is to better understand the topic, which is relatively new and little studied. To achieve this object detailed and in-depth observations provided by qualitative methods are needed. In addition qualitative approach is beneficial, because research questions were fairly vague in the beginning of the research process and developed more focused during the process. This is also common characteristic of qualitative study (Koskinen et al, 2005, pp. 38).

The study is carried out as a multiple case study because it allows observing how different organizations differ in their approach to the research topic. A multiple case study also allows building a bit better general understanding of the topic and exploring further research possibilities. In addition probative value of multiple case study is a bit better when compared to single case study. (Koskinen et al, 2005, pp. 162)

Semi-structured interview is used as a primary data collection method, because the novelty of research topic and mutable research questions require flexibility the method provides. The method allows going through the main themes reasonably fast but it also makes it possible to follow interesting clues, which might surface during the interview. Various online documents and artifacts are used as background information because they are usually better data sources than interviews when dealing with complex technical information or historical information (Koskinen et al, 2005, pp. 107)

4.2 Interview Themes

The research framework of the study was introduced in the end of the literary review part. The framework acts as a conceptual foundation of the research design. Major objective of interviews was to understand how studied organizations are positioned in relation to elements presented in the research framework. This understanding was required in order to be able to answer the research questions.

The aim of the interviews was to answer questions like the following ones: How have case organizations taken into consideration different elements of API value chain? What is the API strategy they have chosen? What is the motivation behind their API efforts and what kind of benefits they are aiming to realize? Have they succeeded in engaging third party developers and fostering open innovation? What kind results has open innovation produced? What kind of challenges have they faced?

Interview themes and some associated questions are presented in Appendix A. Format of interviews was semi-structured and consequently the interview sessions included also various additional questions and conversations, which were often case-specific. Last questions, which are related to significance of APIs as a technology and the concept of API economy were used mainly to facilitate conversation and to acquire background knowledge. Questions included in the interview theme document developed a bit during the interviewing process but the main themes stayed the same.

4.3 Data Collection

The organizations included in the study were selected by browsing web sites and searching for organizations, which provide API and publicly available API documentation. This criterion was selected in order to simplify data collection process and in order to find out organizations, which have put some effort to their APIs. There are lots of organizations, which provide APIs for internal users and business partners but finding these organizations would have taken considerable amount of time. Public API documentation also signals that organization might be using API as a tool to spur open innovation, which is one the focus areas of the study. The catalog of Finnish APIs maintained by API:Suomi community (API:Suomi, 2016) sped up data collection process considerably. Some organizations were included in the study also outside of ApiSuomi catalog, because the catalog isn't a complete

list of Finnish APIs. For practical reasons only Helsinki area based organizations were included in the study.

Studied organizations include businesses as well as public sector organizations. The original idea was to study APIs strictly from business perspective, but public sector organizations were included in the study because some of them employ APIs very innovatively and have been able to build active developer communities around their API efforts. During the data collection process it also became apparent, that there is relatively limited amount of Finnish businesses, which employ APIs extensively at least yet. This is probably due to fact that there are very few big, platform-oriented technology companies in Finland. These kinds of companies are usually the ones, which are able to use APIs most extensively and also have required resources to do so. In addition studied organizations vary in a sense that some of them serve mainly businesses while others serve consumers or citizens. However, given the research questions of the study it would be possible to focus only on businesses, but in that case some interesting API providers like HSL would have to be ignored.

Representatives of the case organizations were contacted by email. Interviews were conducted between April 22 and May 5 at the offices of studied organizations. One interview was done in English and others in Finnish. Interviews were recorded for analysis and documentation purposes. Longest interview took 1 hour 30 minutes and shortest one 30 minutes. Average length of interviews was approximately 56 minutes.

In addition various online materials like API documentations, web sites, blog posts, presentations, news stories and mobile applications were used as background material in interview preparations and in case analysis.

4.4 Data Analysis

In analysis phase recordings of interviews were listened and relevant parts of the recordings were transcribed. The study uses perspective, which Alasuutari (2001, pp. 90) calls as “factual perspective”. This means that the analysis of the interviews focuses on the facts the interviewees disclose, not the way they speak or act. The perspective requires that the researcher assess the veracity of the things interviewees say. They might highlight some things, belittle others or leave something totally unspoken. This might affect on the outcome of the analysis, if the research’s approach to the research data is not critical enough.

The analysis continued by identifying observations, which are associated to the research questions of the study. These observations were classified under titles, which are presented in “Research Findings” section and in the summary table at the end the section. The table is used to give better overall picture of the collected data as Alasuutari (2001, pp. 193) recommends. In addition “Research Findings” section contains brief descriptions of case organizations in order to give reader better understanding of the real-life settings of the study.

5 Research Findings

This section presents empirical findings of the study. Case organizations included in the study are first described briefly. After case descriptions findings related to three research questions defined in the introduction are presented.

5.1 Case Organizations

Organizations included in the study are presented in alphabetical order. All case organizations provide APIs, which are publicly documented and accessible either to public or to partners and clients.

Case descriptions summarize the motivations and goals behind organization's API efforts. The organization's approach to API management and development is described briefly. The descriptions include also relevant background information about the organizations. Table below presents the summary of the analyzed cases.

Organization	Type	Www	API Documentation	Interviewee
City of Helsinki	Municipality	hel.fi	dev.hel.fi	Juha Yrjölä Project Manager
HeiaHeia.com (H2H Performance)	Company (B2B, B2C)	heiaheia.com	developers.heiaheia.com	Olli Oksanen Head of Product
HSL	Public sector organization	hsl.fi	dev.hsl.fi	Tuukka Hastrup Architect
Leadfeeder	Company (B2B)	leadfeeder.com	docs.leadfeeder.com/api/	Herkko Kiljunen Lead Engineer
PlanMill	Company (B2B)	planmill.com	online.planmill.com/pmtrial/schemas/v1_5/index.html	Marjukka Niinioja Senior Consultant & Manager
Yle	State-owned company	yle.fi	developer.yle.fi	Aleksi Rossi Head of Interfaces

Table 2: Summary of case organizations

5.1.1 City of Helsinki

City of Helsinki has a population of 629 512 and approximately 780 different information systems (Helsinki Region Infoshare, 2015a). The city maintains also multiple open APIs, which provide access to data sitting in city's information systems. These APIs include following: OpenAhjo provides access to Ahjo information system, which contains decision-making data like meetings, agenda items, and decisions. LinkedEvents API aggregates data about events around the city. Service Map Backend API provides service point data with filtering possibilities for service point applications. Respa API makes it possible to do resource reservations, such as practice room or meeting space bookings. In addition Snowplows API allows querying the real-time and historical locations of snowplows in the Helsinki area. The APIs are open for everybody and most of them do not require any kind of authentication.

City of Helsinki started open data related initiatives in early 2010s. Since 2011 it has published open data related information through Helsinki Region Infoshare site (hri.fi) in co-operation with other capital region cities. The aim of the open data and open API efforts is to increase transparency, provide better decision-making data and engage citizens.

Currently the city employs also a five-member open source development team, which works on open data related projects and seeks to engage developer community. Source code of team's projects can be found in GitHub. The team fosters API usage by answering questions in online chat room, organizing developer-focused events and publishing blog posts about its activities. Team also maintains developer and documentation portal site dev.hel.fi. The project manager of open source development team was interviewed for the purposes of this study.

5.1.2 HeiaHeia.com (H2H Performance)

HeiaHeia service was launched in December 2009 by startup company H2 Wellbeing. Originally HeiaHeia was casual online training diary, which made it possible to track physical activities and connect with likeminded friends. During the first year service attracted users from dozens of countries and the users logged around one million exercises.

HeiaHeia launched first version of its API in 2010 after a third party developer had asked for it. At the time HeiaHeia didn't offer mobile applications and enthusiastic users used API to build multiple mobile applications for different platforms. According to interviewee application development was "crowdsourced" to third party developers, because the company

didn't have resources to build in-house mobile applications for multiple platforms at the time. HeiaHeia utilized codebase of these third party applications when it built first versions of in-house mobile applications.

Later HeiaHeia has focused on development of in-house mobile applications and pivoted to b2b business model and employee wellness market. Due to these changes importance of its public API has diminished. In early 2016 HeiaHeia merged with coaching company Hintsa Performance. New company H2H Performance offers wellbeing solutions ranging from personal coaching to online wellness platform. HeiaHeia co-founder and Head of Product Olli Oksanen was interviewed for this study.

5.1.3 Helsinki Regional Transport Authority (HSL)

HSL is the organization responsible for the planning and procuring of the public transportation in Greater Helsinki area. HSL has provided public transportation data through open APIs since 2009 and since then amount of data sets provided has increased considerably. Currently HSL provides access to data resources like routes, timetables, service changes, real-time stop predictions, real-time vehicle position and observed stop times. In April 2016 also availability data about just introduced city bikes was added to the selection of available data resources.

There's lot of interest toward data provided by HSL because it is useful for most people living in Helsinki area. First mobile application based on HSL timetable data was released before HSL started to provide public APIs. This application employed data, which was gathered by web scraping timetable data from HSL web pages. After that HSL decided to open its API for public access, because there seemed to be demand for the data. By providing public APIs HSL aims to promote transparency and innovation.

Since 2009 third-party developers have developed dozens of applications, which employ data provided by HSL. User experience of applications varies considerably and the applications answer to wide range of different user needs. The full list of available applications can be found from HSL web page (HSL, 2016). Supported platforms include web, iOS, Android, Windows Phone and Symbian. Some of the applications are also commercial like ReittiGPS, Reitit and Andropas. Full version of these apps is paid download in app stores.

There's an active developer community around HSL developer hub site dev.hsl.fi and its social media channels. HSL provides developers API documentation and lot of other

material including API console, tutorials, presentations and various demo applications. In addition HSL encourages API usage by organizing hackathons occasionally. Group of developers who are familiar with the APIs is fairly big, because also some programming courses in the University of Helsinki have employed APIs provided by HSL.

HSL and Finnish transport agency are publishing new version of trip planning service Reittiopas during 2016. New version will enable features like ordering tickets through API. Source code of new service will also be open. Architect of dev.hsl.fi was interviewed for the purposes of this study.

5.1.4 Leadfeeder

Leadfeeder is Helsinki based startup, which develops lead generation tool for business-to-business companies. Leadfeeder was originally founded in 2012 and currently has 12 employees. Leadfeeder connects to its clients Google Analytics accounts and enriches web analytics data with data from other sources. Leadfeeder aims to uncover website visitors and turn them into sales leads by telling which companies and industries visitors represent. Leadfeeder uses SaaS business model and employs freemium pricing strategy. Limited basic subscription to service is free but paid monthly subscription is required to access all features and data.

Leadfeeder is good example of modern API centric business. It focuses on refining and visualizing data, which is provided by external data source, Google Analytics, through API. Leadfeeder provides API as a part of its premium subscription. API was launched in summer 2015 because multiple partners and clients had requested it. API is still in closed beta testing. API provides access to data assets like leads and lead visits. API is used to integrate partners' customer relationship management (CRM) tools to Leadfeeder so that they can present Leadfeeder data in their systems. API is also used to fetch Leadfeeder data to client's in-house systems.

According to interviewee currently clients assume that business-to-business tool like Leadfeeder has some kind of API. Some clients also require it. In addition Leadfeeder wants to embrace integration possibilities provided by APIs, because the company itself is using heavily APIs provided by other companies. Lead Engineer of Leadfeeder was interviewed for the study.

5.1.5 PlanMill

PlanMill is Helsinki based Customer Relationship Management (CRM) and enterprise resource planning (ERP) software provider. Its product is cloud-based SaaS solution, which clients are mostly professional services companies. PlanMill currently has 28 employees and over 100 client companies in over 25 countries. The company was founded in 2001 as a subsidiary of TJ Group and became an independent company in 2006. The story of PlanMill started from a project management product called Nokia Planner in the late 1980s.

PlanMill API 1.0 was released in 2009. API is very important part of PlanMill's product, because almost all the clients have some kind of integration needs between PlanMill platform and their business applications. Before they build API, PlanMill had to resort customized point-to-point integrations between their systems and client's systems.

According to interviewee API was selling point and source of competitive advantage for PlanMill, because most ERP providers did not provide API at the time. First version of API was used in many integration projects, but it had also major usability problems. The API was hard to use for external developers because it was automatically generated and exposed too much complexity of the system to API users. PlanMill developed API further according to developer feedback. Improved and better-designed API version 1.5 was launched in autumn 2015.

PlanMill API is intended for company's customers and partners. Its approach to API strategy could be described as "partner". According to interviewee API is now basic requirement for business-to-business service like PlanMill, because most clients expect that such a service provides some kind of API. In addition to public documentation PlanMill has held seminars for its customer and partners in order to promote possibilities provided by API. PlanMill also gets constantly technical feedback about the API from external developers.

Currently PlanMill is using its API also internally by building its new user interface components on top of the API. According to interviewee API speeds up client onboarding process and integration projects. Senior Consultant and Manager who has been involved in PlanMill's API project from the beginning was interviewed for the purposes of this study.

5.1.6 Yle

Yle, Finland's national public-broadcasting company, opened portion of its APIs for public access in spring 2015. These public APIs allow external developers to access program information, play video streams and report usage statistics. They can be used to create Yle

Areena like applications for different platforms. Aim of the public API initiative is to foster innovation, speed up product development and increase transparency.

External developers have employed APIs to create Yle Areena player applications for various platforms. Anybody can access API after acquiring API key, but applications built on top of API have to follow terms of use stated in Yle API license. Commercial usage of content provided by Yle is disallowed. In this sense Yle differs from HSL, which APIs are also used by paid mobile applications. The restriction is implemented due to copyright reasons. In order to encourage API usage, Yle maintains developer hub site at developer.yle.fi. Site helps developers to get started and provides documentation and tutorials.

Yle utilizes APIs heavily also internally. It has transitioned into API centric, microservices influenced software architecture. It has multiple centralized APIs, which provide data and services for various sites and applications operated by Yle. The content published on these sites and applications is fetched from APIs. Only small portion of APIs has been exposed for public access. Yle's head of interfaces, the person who manages development of public and internal APIs, was interviewed for this article.

5.2 Results of Open Innovation Process

The first research question the study aims to answer is: **What kind of results has open innovation process produced for API providers?** The question employs the concept of open innovation, which was presented in detail in literature review part of the study. The question aims to find out what kind of outcomes have case organizations achieved by engaging third party developers. The analysis focuses especially on inbound open innovation.

In general it seems that organizations can achieve visible results by engaging third party developers and fostering open innovation. This requires that organizations put efforts into API documentation and provide third party developers support when they need it. Also the nature of the data or services they provide through API seems to be very important. If the data is interesting and useful from the users' point of view, they use it to solve their own problems and often share the results of their work. In this case building developer community around API is relatively easy. This largely explains why there are so many different applications built on APIs provided by HSL. Public transportation data is very useful for almost everybody.

Enthusiastic and technically capable users are good source of external ideas, innovations and knowledge for customer oriented organization, but also organizations operating in business-to-business environment can benefit from open innovation. The results of open innovation process are just a bit different as following analysis shows. Observed results of open innovation are classified under following titles.

5.2.1 Applications For New Platforms

Applications for different platforms, especially mobile platforms, seem to be most visible result of open innovation especially in customer or citizen focused settings. HeiaHeia employed the know-how of third party developers to kick start its mobile application development efforts when it didn't have resources to build in-house applications as described earlier. HSL offers currently only web-based version of its trip-planning tool, Reittiopas. Third party developers have built all the trip-planning focused native mobile applications. Some developers have also been able to build business on the applications by making full version of application paid. Yle is providing Areena player applications for major platforms but third party developers have used its API to build applications for smaller platforms like Os X, AppleTV, HbbTV and open source media player Kodi. Third party developer has also built Ahjo Explorer Windows Phone application, which utilizes Open Ahjo API provided by city of Helsinki. The app makes it easier for Windows Phone users to follow the political decision making of the city of Helsinki.

These examples show how organizations can leverage creativity of third party developers to reach new users on new platforms and deepen the relationship with these users by offering native applications. From API provider's perspective third party applications can be seen also as prototypes, which offer valuable knowledge for API provider, if there is a need to build in-house application for a particular platform later. In addition third party applications allow API providers to focus on their core products and platforms.

The findings are in line with results of Aitamurto and Lewis (2011) who studied open innovation in the context of open APIs provided by news organizations. They observed that in US third party developers used API provided by National Public Radio (NPR) to create applications for various niche platforms. In addition NPR launched its first official iPhone application after third party application has proven that there is a demand for such an application. The findings are also in line with the open innovation thinking of Chesbrough and Garman (2009). They point out that in order to focus core products and reduce product

development costs businesses should leverage open innovation “*Let others develop your non strategic initiatives*”.

5.2.2 Application For New Use Cases

Third party developers also build applications for totally new use cases. One good example is BlindSquare (Helsinki Region Infoshare, 2015b), which is location based iOS application developed for the blind and visually impaired. The application describes the environment, announces points of interest and street intersections using voice synthesis as user moves. It uses data provided by Foursquare, but utilizes also Reittiopas API provided by HSL and service map API provided by City of Helsinki.

Other examples are various mobility applications based on APIs provided by HSL. They answer various use cases including following: How to get from here to place X? What time will next bus leave from nearest bus stop? The applications might also focus on certain part of public transportation system like metro or offer real time visualization of public transportation in Helsinki.

In addition third party applications offer different user experiences. In April 2016 HSL published an API, which provides availability data about city bikes. Quite fast third party developers built applications on this data. The user experiences of these applications range from minimal (citybikes.github.io) to polished and visual (kaupunkifillarit.fi).

The applications, which respond to new use cases, help API provider to serve better certain user groups like the blind and visually impaired in the case of BlindSquare. The applications also signal, which use cases are important for users in general and what kind of user interface solutions might work. In a sense the third party applications help API provider to reach new user groups but they also do also prototyping for API provider. API provider can learn a lot from the third party applications when it develops its own services.

5.2.3 Client Libraries and Shared Code

In addition third party developers write and share code, which makes it easier to utilize the API in other applications. For example, in online code hosting service GitHub there are multiple Yle API client libraries for different programming technologies created by third party developers (github.com/paksu/yleapijs, github.com/oniongarlic/php-yle-api, github.com/jsalonen/yle-api). Also developers who have worked with PlanMill API have

shared the results of their work (github.com/Codaone/planmill-rest-client, github.com/futurice/haskell-planmill-client).

This kind of activity speeds up the third party application development and increases the visibility of API. It also grows developer community around API, which in turn speeds up the creation of new applications, ideas and innovations.

5.2.4 Feature Ideas

By engaging third party developers API providers get ideas, which might end up to their own product roadmaps sooner or later. Interviewee from HSL tells about simple app concept, which would include button that could be used to signal driver that passenger would like to jump out of the buss on the next buss stop. The app could be also used to signal that passenger wants to jump in to buss from a particular buss stop and driver would see this information. Implementation of this kind of ideas requires actions from API provider but they might become reality at some point of time.

Interviewee from Yle also tells about innovative ways some developers have presented data provided by Yle on map based on location information of data items. The new ways of presenting existing data might affect how interfaces of these services will be developed in future.

5.2.5 Technical Feedback & Improvements

APIs might cause lot of interactions between API provider and external developers. For example, interviewee from PlanMill tells that she knows at least twenty of the developers by name. In total hundreds of developers have worked with company's API since its launch in 2009. The interviewee tells that they sometimes get very detailed feedback about their API.

“Sometimes we get feedback from developers, which says that API should behave like this according to the standard, but is now behaving like this. Here is the test case and the expected value is this.”

All studies API providers get at least some technical feedback about their APIs. The amount of feedback depends largely on the amount of developers working with the API and the complexity of API. This kind of exposure to external knowledge helps API providers to technically develop their APIs further and fix possible problems fast.

5.3 Realized Benefits of APIs

The second research question the study aims to answer is: **What are the realized benefits of API for API provider?** The question uses same classification of benefits as the literary review part of the study. Benefits related to open innovation are excluded from this analysis, because they were already analyzed in last section. The analysis focuses on the benefits, which are relevant both to business and to public organizations.

5.3.1 Wider Reach of Service

The applications made possible by APIs help API providers to reach new user groups as mentioned earlier. In addition API makes data more accessible to other services including different kind of aggregation services, which combine data from multiple sources. For example, Google Maps and Here Maps use API provided by HSL to fetch and display public transportation options, when user is looking for directions from place X to Y. This helps HSL serve customers like tourists, who might not be aware of its own services.

Another example is City of Helsinki, which provides data about events in Helsinki region through its Linked Events API. This data is consumed among others by Eventmore mobile app, which combines event data from multiple sources. Again API helps organization to reach wider audience.

Similarly Leadfeeder has done partnering deals with CRM providers, which display data provided by Leadfeeder API for their clients. Some have built a separate view for Leadfeeder data in their services. The partnerships help Leadfeeder to reach new customer groups. The partnerships also create value for partners and customers. The partners are able to show more intelligent data to their customers and customers are able to see all the relevant data by using only one service.

5.3.2 Business Process Automation

Various business process integrations are import use case for APIs especially in business-to-business environment. Interviewee from PlanMill tells that API has shortened their sales cycle and sped up onboarding of new customers considerably. The integrations required by customers take fewer resources and less time to implement, when there is well documented API.

“Earlier we used to do lot of one-to-one integrations, which took lot of time. Even understanding what you should do took a lot of time. Now it’s much more easier when you

can say that here's our API documentation, do what ever you like to do. Of course it does not take away all the problems, but it makes things easier"

According to interviewee API has allowed PlanMill to focus more on its product and less on the client specific customizations.

"When we are looking at the share of the revenue, which was coming from professional services and these customizations earlier, we can see that it was huge amount. Now it's much smaller percentage, which means that we are now more of a product company. Now we have to a lot less customizations to do, which is good for us and good for our customers."

Also Leadfeeder has noticed that API makes it possible to move at least some integration implementation projects to developers working for partners and clients.

"World is full of different CRM systems and there are also lot of in-house systems. We cannot handle them all. API allows other parties to do the integration, if they have some one who can do it", interviewee from Leadfeeder describes.

5.3.3 Increased Agility

Organizations can also take advantage of APIs by using them internally. APIs can be used to implement service oriented or microservices architecture as described earlier. Yle uses internally multiple centralized APIs, which provide content for its various sites and services. According to interviewee from Yle this microservices influenced architecture has sped up development of new services considerably, because developers don't have to worry about details of various underlying content management systems anymore. They get all the data from APIs in standardized format.

PlanMill has noticed that API eases internal product development by providing clear separation between user interface layer and back-end system. Due to this developers are able specialize either user interface development or backend development. The company is building new user interface components on the top of the new API and is able to use totally new technologies in user interface layer, because it's separate from older back-end system.

Also Aitamurto and Lewis (2011) observed the internal benefits of APIs in their study. *"The use of open APIs also benefits the news organizations internally. The launch of an open API initiative is often tied to larger structural changes within the organization, such as retooling the content management system (CMS) and creating a systematic, organization-wide use of APIs. The API gives a formulaic and structured way to do product development."*

By requiring comprehensive APIs to information systems they use, organizations can avoid situations in which they are dependent on the subcontractor who originally built the system, situation known in Finnish as “toimittajaloukku”. Thanks to API further development of the system is easier and organization can hire another subcontractor, if the original subcontractor puts the price of further development too high. Interviewee from City of Helsinki points out that this is one reason why Helsinki favors openness and APIs.

5.4 Challenges of API Management and Development

The third research question the study aims to answer is: **What are the main challenges of API management and development?**

All case organizations had faced some kind of technical challenges during API development, but research findings focus mainly on business and cultural challenges. The observed challenges are classified under following titles.

5.4.1 API Awareness

API is fairly new and technical concept. Due to this it might be hard to get all the necessary people in the organization to understand the purpose of API. According to interviewee from PlanMill the one of the most challenging things during company’s API efforts has been to communicate the benefits of API to company’s consultants and customer facing people. Why should they talk about API with customers? PlanMill has increased API awareness inside and outside of the company by organizing events like seminars around API topics.

The API awareness is especially important in business-to-business setting where API might be one of the selling points of the product. If customer-facing people cannot communicate the benefits of API to customers, the company cannot utilize the full potential of API.

5.4.2 Personal Data

The purpose of APIs is to expose data to organization’s internal users, partners or public. However, personal data is special case of data, which is regulated by Finnish law and EU directives. If information system contains personal data, the handling of personal data should be taken into consideration also during API development.

In open data setting personal data is usually removed before data is served through API, because open data should not contain personal data. In business-to-business setting it is

important to make sure that also the application on the other end of the integration is secure enough to handle personal data, if integration transfers personal data.

Challenges associated to personal data were mentioned during two case interviews.

5.5 Summary of Findings

Findings presented in this section are summarized in following table. The table presents observed results of open innovation process, realized benefits of API and challenges of API management by case organization.

Organization	Results of open innovation process	Realized Benefits of API	Challenges of API management and development
City of Helsinki	Applications for new platforms Applications for new use cases	Wider reach of service Increased agility	Personal data
HeiaHeia.com (H2H Performance)	Applications for new platforms	Wider reach of service	
HSL	Applications for new platforms Applications for new use cases Client Libraries and shared code Feature Ideas	Wider reach of service	
Leadfeeder		Wider reach of service Business process automation	
PlanMill	Client Libraries and shared code Technical feedback & Improvements	Wider reach of service Business process automation Increased agility	API Awareness Personal data
Yle	Applications for new platforms Client Libraries and shared code Feature Ideas	Wider reach of service Increased agility	

Table 3: Summary of research findings

6 Discussion and Conclusions

This section presents conclusions of the study. The section highlights some interesting perspectives and insights, which emerged during the analysis of the research findings. It also investigates implications for practice and limitations of the study.

Finally the section explores some possibilities for further research, because the topic of the study, APIs, is still relatively new and little studied phenomenon, which offers various possibilities for future studies.

6.1 Conclusions of Research Findings

Six case organizations analyzed in the study make up a fairly heterogeneous group. They include businesses and public sector organizations. Some of the organizations serve mainly customers or citizens. Others operate in business-to-business environment. Due to this research findings enable a wide range of interpretations. The conclusions of the study highlight couple of interesting perspectives to research findings. They include open innovation potential of APIs, possibilities to reach new audiences using APIs, possibilities to scale business with APIs and benefits of APIs in internal use.

6.1.1 API as an Open Innovation Tool

Research findings show that APIs can be used to engage third party developers and leverage creativity of people working beyond boundaries of API provider's organization as Chesbrough theorized in 2003. This requires that API is well documented and relatively easily accessible. API provider should provide support for third party developers when they need it. Also nature of the data or services exposed by API is important. If data is useful to third party developers and they can use it solve some practical problems, premises for open innovation are good.

According to research findings open innovation process might produce lot of interesting and concrete outcomes for API providers. These include applications for new platforms, applications for new use cases, ideas for new features, technical improvements and programming libraries, which speed up development of new applications. From product development perspective these outcomes offer to lot of information and valuable lessons for API provider. They might speed up product development and lead to better in-house products in the future. Partly these outcomes of open innovation can be seen as prototypes, which

signal API provider what works and what do not work and how to approach different use case or user experience challenges.

Research findings related to open innovation are mostly in line with Aitamurto & Lewis (2011), who studied open innovation in the context of APIs provided by US media organizations. They observe following: *“The open APIs have taken a role of an external R&D lab, in which the external collaborators use the content made available by the news organization and develop applications based on the content. This leads to experiments and forms of exploration that wouldn’t (and couldn’t) be done by the news organizations alone.”*

6.1.2 API as a Business Scaling Tool

Especially in business-to-business environment API can be used as a tool to scale integration capabilities with clients and partners. According to research findings well-documented and well-designed API speeds up integration projects and makes it easier to move the implementation of integration project to opposite party like client or partner or its subcontractor. The cases PlanMill and Leadfeeder are good examples of this. In many cases the integration does not require any extra work from API provider. This makes it possible for API provider to put more focus on product development, to speed up customer acquisition and to scale up business faster. This is very beneficial especially for businesses, which employ SaaS based business model. Also Jacobson, Brail and Woods (2012, pp. 17) highlight this benefit.

Customer-focused companies can use API as a tool to scale up business by leveraging API and creativity of third party developers to reach small user segments as described in last section. This allows them to put more resources on the development of the core product and scale up the core operations.

6.1.3 API as a Tool to Reach New Audiences

APIs can be used to reach new audiences as multiple analyzed cases suggest. Developers use Yle’s API to build Arena applications for platforms like HbbTV and open source media player Kodi. Third party developer also uses APIs and data provided by HSL and City of Helsinki in BlindSquare app, which is intended for the blind and visually impaired.

The examples show how APIs allow organizations to reach very different user groups, serve better the needs of these user groups and strengthen their relationship with members of the groups. These audiences may be so small and diverse that API provider cannot serve

them properly using in-house resources, but APIs make it easier to leverage resources of partners or third party developers.

6.1.4 APIs as a Tool to Improve Internal IT Architecture

This study has focused mostly on the open innovation perspective and API enabled collaboration possibilities, but potential benefits of internal APIs are so significant that they cannot be ignored when conclusions of the study are drawn. Organizations can use APIs as building blocks of improved and more agile internal IT architecture, which speeds up development of new services and makes it easier to share data between units. Modern service oriented architecture and microservices architecture represent this kind of developments. (Bradbury, 2016) Good example is Yle, which has adopted microservices influenced architecture. Also case PlanMill shows how APIs can be used to improve legacy architecture by creating better separation between different layers of information system.

6.2 Implications For Theory

The study proves that theory of open innovation can be applied to interactions between API provider and consumers of API like business partners and third party developers. APIs reduce significance of organizational boundaries by facilitating outbound and inbound flows of knowledge. In the context of APIs data and services exposed by API provider form the outbound knowledge flow. If the data helps API consumers to solve some practical problems, they create and share applications, which might be valuable to other API consumers and API provider. In the context of APIs applications form the inbound flow of knowledge (Aitamurto & Lewis, 2011). The findings of the study are mostly in line with open innovation theory and show that organizations can speed up product development and create value for their customers by leveraging open innovation.

6.3 Implications For Practice

The literary review section of the study introduces concepts like API value chain, different approaches to API strategy and benefits of APIs, which are valuable information to organizations planning their API efforts. They provide the means to evaluate possibilities of API and to match API with organization's business model and business environment. The organizations planning API should review that they have taken all the perspectives in the consideration before they go live with their API.

The empirical part of the study provides valuable insights for current and future API providers. The case descriptions and research findings recount how the studied organizations have used APIs to their advantage and what kind of challenges they have solved with APIs. The study is able to provide insights for wide variety of actors, because the analyzed organizations include customer focused companies, b2b companies and public sector organizations. The value of qualitative study is often in details. The last section sums up the research findings and presents conclusions of the study in compact format.

6.4 Limitations of Study

This study shares many common characteristics with other qualitative case studies. The number of analyzed cases is fairly low. The cases are all concentrated in the same geographic area. The cases are handpicked rather than random sampled. The selected research method, semi-structured interview, has many known shortcomings. Due to the selected research method the findings depend partly on the way interviewees reconstruct reality, what they decide to say and what they decide to leave unsaid. The research findings are also susceptible to various biases because the analysis was conducted by single researcher who used fairly intuitive analysis method.

Therefore typical limitations of the qualitative study apply also for this study and generalizability of the research findings is quite low. (Koskinen et al, 2005, pp. 265) Rather than in generalizability the value of the study lies in details and insights it provides. In addition the research findings are in line with theory of open innovation (Chesbrough, 2003) and with previous research (Aitamurto & Lewis, 2011), which increases the reliability of the study.

6.5 Further Research

One goal of the study is to explore openings for future studies. The APIs are still relatively young and little studied topic and due to this they provide multiple possibilities for further research. This section aims to give some selected ideas and inspirations for further studies.

Survey type of study would make it possible to study APIs using more quantitative research approach. The survey could target IT decision makers and it could focus on the topics like attitudes toward APIs and openness in general, organization's internal use of APIs or implementation technologies and standards in use. The study might be rather laborious to

conduct, but it would help to understand better how widely utilized APIs are, for example, in Finland.

A single case study in turn could provide even more detailed information about opportunities of APIs. A single case study focusing on an organization, which uses APIs either to transform its internal IT architecture or exposing its data assets to outside world, could be rather interesting, especially if the case company represented some traditional industry. As told in the introduction in US traditional companies like Walmart have published public APIs, but in Finland this kind of examples are still rare. The study would give in depth information about possibilities and challenges of APIs in the context of just one company.

In addition one possibility would be to use participant observation as a research method and study a selected developer community. This would give detailed information about incentives of developers and interactions between developers and API provider. The study could possibly give very detailed information about the mechanics of open innovation processes.

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Interviews

Marjukka Niinioja, Senior Consultant and Manager, PlanMill Oy, 22.4.2016, interviewed by Antti Hatvala. The recording is in the writer's possession.

Juha Yrjölä, Project Manager, City of Helsinki (dev.hel.fi), 25.4.2016, interviewed by Antti Hatvala. The recording is in the writer's possession.

Olli Oksanen, Head of Product, H2H Performance Ltd (Heiaheia.com), 26.4.2016, interviewed by Antti Hatvala. The recording is in the writer's possession.

Herkko Kiljunen, Lead Engineer, Leadfeeder, 27.4.2016, interviewed by Antti Hatvala. The recording is in the writer's possession.

Tuukka Hastrup, Architect, HSL, 3.5.2016, interviewed by Antti Hatvala. The recording is in the writer's possession.

Aleksi Rossi, Head of Interfaces, Yle (Finnish Broadcasting Company), 6.5.2016, interviewed by Antti Hatvala. The recording is in the writer's possession.

Appendix A: Interview Themes



Web APIs: Interview Themes

1. Background

- (What is the core business of your business/organization?)
- (How many employees do you currently have?)
- (When was the organization founded?)

2. API Basics

- What kind of assets/data does your API expose?
- Who is allowed to access your API?
- What was your original motive to publish API?
- When was the first version of the API published?
- What is the target audience of your API?
- What kind of API documentation or tools do you offer to developers?

3. API Use Cases

- What kind of API use cases you have you had?
- What is the most common use case for your API?
- What is the most surprising use case you have had?
- Do you use your API internally?

4. API & Innovation

- Have you got any new ideas from external developers? What kind of ideas?
- Has API fostered any specific innovations? What kind of?
- Has API caused any internal business or IT changes for your organization?
- Do you promote usage of the API somehow? How?
- Can you estimate roughly how many developers have worked with your API?



5. Benefits, Opportunities & Risks

What are the main benefits of API to your business/organization?

What are the main opportunities provided by API to your business/organization?

What are the main challenges related to API management and development?

What are the main risks associated to API from your point of view?

6. API & Business

How important is the API for your business?

What is the role of API in your business?

Are people outside of it department familiar with term API and its purpose?

Do you measure API usage?

Does API give you some kind of competitive advantage?

7. APIs & Future

How are you going to develop your API in future?

What do you think about significance of APIs as a technology?

What do you think about “API Economy” as a concept?