ETLA Raportti | Report | 93 19.9.2019

What Are the Benefits of Data Sharing?

Uniting Supply Chain and Platform Economy Perspectives

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Suggested citation:
Huttunen, Henri, Seppälä, Timo, Lähteenmäki, Ilkka & Mattila, Juri (19.9.2019).
"What Are the Benefits of Data Sharing? Uniting Supply Chain and Platform Economy Perspectives".

ETLA Report No 93. https://pub.etla.fi/ETLA-Raportit-Reports-93.pdf

Abstract

Data as a resource and data sharing enable competitive supply chains and present-day digital platform business models. The recipe for these competitive supply chains will no longer be contingent on how different companies contract to share data in their existing business networks but how these companies make these contracts available for the others in multisided markets. Advancing the availability of data sharing contracts has led to novel internal and external operational efficiencies and to new types of strategic opportunities.

Data sharing is nothing new. Approximately 49% of the companies already share data with other companies. How has data sharing emerged between companies? What types of benefits have companies reached by sharing data? Those are the two research questions we are answering in this study. Additionally, we map the trajectory of data sharing technologies and their benefits for companies.

External strategic opportunities cannot be reached unless the product, service and software architectures are modular; in addition, the boundary resources are not being considered by the companies. Finally, the tools for evaluating the value capture of indirect network effects is missing from widely accepted business case valuation methods. The question remains – what type of data resources can companies treat as proprietary or as shared?

Tiivistelmä

Mitkä ovat datan jakamisen hyödyt? – Toimitusketjujen johtamisen ja alustatalouden näkökulmat

Data resurssina ja datan jakaminen mahdollistavat kilpailukykyiset toimitusketjut ja digitaalisten alustojen liiketoimintamallit. Nykypäivän kilpailukykyisten toimitusketjujen resepti ei enää ole riippuvainen siitä, miten eri yritykset tekevät sopimuksia datan jakamisesta verkoissaan, vaan siitä, miten nämä yritykset mahdollistavat datan jakamisen kolmansille osapuolille monisuuntaisilla markkinapaikoilla. Nämä uudentyyppiset sopimukset ovat luoneet yrityksille uusia sisäisiä ja ulkoisia toiminnan tehokkuuksia, kuten myös strategisia liiketoimintamahdollisuuksia.

Tietojen jakaminen ei ole mitään uutta. Noin 49 prosenttia yrityksistä jakaa jo dataa muiden yritysten kanssa. Kuinka datan vaihto on kehittynyt yritysten välillä? Millaisia etuja yritykset ovat saavuttaneet jakamalla dataa? Nämä ovat ne tutkimuskysymykset, joihin vastaamme tässä tutkimuksessa. Lisäksi kartoitamme datan jakamisen tekniikoiden etenemistä sekä niiden operatiivisia ja strategisia liiketoiminallisia hyötyjä yrityksille.

Ulkoisia strategisia liiketoimintamahdollisuuksia ei voida saavuttaa, elleivät tuote-, palvelu- ja ohjelmistoarkkitehtuurit sekä liiketoiminta-arkkitehtuuri ole modulaarisia. Lisäksi yritysten tulee harkita rajaresurssien käyttöä. Erityisesti epäsuorien verkkovaikutusten liiketoiminnallisen arvon arvioimiseksi ja määrittämiseksi puuttuvat laajalti hyväksytyt arviointimenetelmät. Kysymys yrityksille on edelleen se, että mikä data on heille yksinoikeudellista tai mitä dataa yritykset voisivat jakaa jalostettavaksi muille eri osapuolille.

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KTM **Juri Mattila** on Elinkeinoelämän tutkimuslaitoksen tutkija ja Aalto-yliopiston tohtorikoulutettava.

Acknowledgements: This report has been drafted as a part of the Industry and Data research project by The Finnish Innovation Fund Sitra and by Digital Disruption of the Industry (DDI) research projects funded by Academy of Finland. Sitra's IHAN project builds the foundation for a fair, human-driven data economy. In the new model, data is shared through the individual's or data source's consent, leading to transparency and trust in the use of data, as well as perceived value among all network members from individuals to companies and society at large.

Kiitokset: Tämä raportti on osa Teollisuus ja data -tutkimusprojektia, jonka on rahoittanut Suomen itsenäisyyden juhlarahasto Sitra, ja Teollisuuden digitaalinen murros -tutkimusprojektia, jonka on rahoittanut Suomen Akatemia. Sitran IHAN-projektissa luodaan yhteiset, kaikille selvät pelisäännöt ja toimintamalli datan jakamiseen ja hyödyntämiseen. Reilun datatalouden verkostoissa data liikkuu vain yksilön luvalla ja ennalta sovittuihin käyttötarkoituksiin. Luottamus lisää palveluiden tuottamiseen tarvittavan datan määrää, josta hyötyvät kaikki dataverkostojen jäsenet yksilöstä yrityksiin ja yhteiskuntaan.

Keywords: Data as a resource, Data sharing, Boundary resources, EDI-economy, API-economy, Network Effects, IHAN-project

Avainsanat: Data resurssina, Datan jakaminen, Rajaresurssit, EDI-talous, API-talous, Verkostovaikutukset, IHAN-projekti

JEL: M21, O30, P49

Contents

Data sharing is a common business practice for 49% of companies

Data can be found everywhere—Companies have systematically started to gather all kinds of data of their processes and customers by integrating more connectivity into their products, machinery, and services (Meyer & Schwager, 2007; Tao et al., 2018). Additionally, companies acquire data with different techniques (Yin et al., 2015). However, companies gather, acquire and develop data typically to satisfy their own company needs. Moreover, much of the data that are being gathered, acquired or developed almost never leave their internal systems or systems they control—the data are not shared externally nor openly (Fitzgerald, 2013). When specific use case data are shared by the companies, they tend to create their own copies of data.

The unused and unshared data could potentially be very valuable to another company. Many companies monetized data by, e.g., processing and selling it (LaValle et al., 2011; Liozu & Ulaga, 2018). Many companies share revenues of the sold innovations, e.g., software that is being developed from someone else's data (Parker & Van Alstyne, 2018; Rajala, Rossi, & Tuunainen, 2003). Many companies are afraid of sharing data because someone else could benefit from the data. Financially, it could be an attractive proposition to test digital platform-related data sharing practices and business models as shown by successful technology platforms such as Amazon, Apple and Google who capitalize on the products and services developed by external suppliers to gain competitive advantages over the other companies (Benzell, LaGarda, & Van Alstyne, 2017; Gawer & Cusumano, 2016).[1]

About the data: Data can be multiplied, shared among companies using different information technologies and reproduced in many ways (Levitin & Redman, 1998). However, as general rule, data cannot be owned. Data may belong to various actors, but they cannot be owned in the legislative sense (Ailisto et al., 2015). The very nature of the data is such that it is a multipurpose commodity (Nikander, Mattila, & Seppälä, 2018). Additionally, data can be considered as any resource, just as, e.g., human and financial resources. Data as a resource comprise different characteristics from other resources. Data have different managerial implications when being considered as a resource by the companies. (Levitin & Redman, 1998).[2]

There is a prominent number of companies that have considered data as a resource and data sharing practices during the last decades. Approximately 49% of Finnish companies in 2019 consider data as a resource and use data sharing as a common business practice (see "About the Research"). The number of companies using new operational models and technologies for enhanced interoperability and data sharing is estimated to grow 2.4% annually[3].

This study continues as follows: First, we describe the model of categorizing data-related benefits. Essentially, the described model could be used to categorize any technology benefits used by the companies. From the model, we draw a key observation of data sharing. Second, we offer the technology trajectory of data sharing technologies, starting from the 1970s until today. We also characterize their benefits for companies (see "About the Research"). These three trajectories are the following: 1) electronic data interchange (EDI); 2) internet EDI; and 3) application programming interfaces (API). We finalize our study with concluding comments and discussion.

About the Research

To answer the proposed research questions, the technological readiness and adoption were studied with the historical data of Finnish companies by Statistics Finland, with some additional data from The Research Institute of the Finnish Economy. Six high-profile experts with a diverse set of business and technological backgrounds were then interviewed to complement the statistics and understand how the exploitation and the impact of data have developed, in their experience. From Statistics Finland, we used the annual data of "ICT and e-commerce in companies" from the years 2003–2016 and biannual "Innovation research" from the years 2002–2016. The data sets have been gathered from mandatory surveys across all companies in Finland, and there are approximately 3,000 responses each year in the ICT survey and approximately 2,500 responses in the innovation survey. Additionally, we used the results of "The importance of data in business" survey conducted by The Research Institute of Finland in 2015 in which there are responses from approximately 1,300 Finnish companies across all industries.[4]

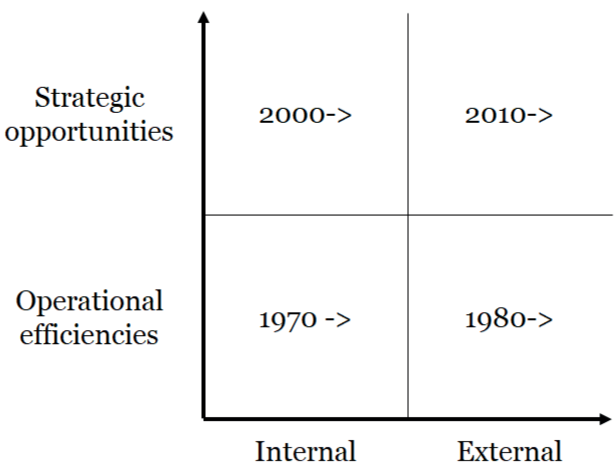
Evaluating the benefits of data sharing—Modern evaluation tools and missing methods

This study offers a list of two prerequisites from the literature for the companies to operationally consider. The two prerequisites are: (*micro*) *modularity and tasks* (Tiwana & Konsynski, 2010; Voss & Hsuan, 2009) and *boundary resources and the interfaces* (Gawer, 2014; Ghazawneh & Henfridsson, 2010) of their technology, product and service implementations.

The data-related benefits and timing can be categorized into two dimensions: operational efficiencies and strategic opportunities, and further into internal and external benefits within these dimensions (see Figure 1 (Huttunen, 2019)[5]. Additionally, to prerequisite, this study describes the technoeconomic trajectory of data as a resource and the data sharing practices and benefits thereof.

The internal benefits enabled by using and sharing data in companies and in one-to-one as well as in many-to-one contractual relationships can be categorized into operational efficiencies, focusing on cost reductions (benefits include: reduced need for manual labor, increased utilization rates of the assets, predictive analytics in maintenance and other similar forecasting tasks) (Davenport, 2006; Mukhopadhyay, Kekre, & Kalathur, 1995; Tao et al., 2018), and strategic opportunities that enable companies to generate more revenue (benefits include: incremental innovations, complementing current offerings with data products and better customer targeting for individual companies) (Davenport & Kudyba, 2016; McAfee & Brynjolfsson, 2012; Wixom & Boss, 2017). Furthermore, Tao et al. (2018) outline how selling analytics with manufacturing machinery has enabled new business opportunities, and Davenport and Kudyba (2016) explain how enough data coupled with predictive analytics can reduce the maintenance and upkeep costs of various assets.

Figure 1 Categorization of identified data-related benefits



Internal Operational Efficiencies—By internal operational efficiencies, we mean that individual companies are eliminating inefficiencies by unideal uses of available resources and internal interfaces between different information and technology systems. Additionally, internal operational efficiencies can be described as relationships between two contractual parties, i.e., in one-to-one relationships supported by one-to-one interfaces. In these relationships, there is typically one source for the data and one output.

Internal Strategic Opportunities—By internal strategic opportunities, we mean that sharing data enables companies to make better decisions and design better products and services as well as generating more revenue with available resources. In these situations, the data flow between the companies can be described as follows: many-to-one relationships and interfaces, i.e., several sources for data, one output.

The external benefits, both strategic and operational, can only be achieved if the company is willing to share the data externally as well. Operational efficiencies among partners and the value chain are already exploited to some extent, as data is shared selectively, and hence, cost reductions have been available for some time already (benefits include: smaller inventories and *mitigating bullwhip effect*) (Hofmann, 2017; Lee, Padmanabhan, & Whang, 1997). Sharing data with external parties enables external benefits as well—creating the internal and external subdimensions into the framework—as both the operational efficiencies and strategic opportunities can be developed outside the focal company. For external operational efficiencies, ample literature exists on the benefits of information sharing in supply chains (e.g., Cachon & Fisher, 2000; Lee, So, & Tang, 2000; Lotfi et al., 2013; Stevens, 1989), and the expert interviews suggest that the ability of external companies to provide analytics as a service, improving the focal company's performance, can also be categorized as an external operational efficiency.

External Operational Efficiencies—By external operational efficiencies, we explain how companies streamline their processes and operations across the supply chain in the form of sharing information and data through agreed communication methods and tools, e.g., customer and supplier portals. The relationship between the many contractual parties can be described as follows: one-to-many interface — one source of data, many outputs.

Being able to capitalize on the external strategic opportunities requires companies to share data much more widely and openly (benefits include: monetizing complementary innovations and increasing company value by opening APIs in larger business networks) (Benzell et al., 2017; Parker & Van Alstyne, 2018) — it is risky, however, as the benefits can be unpredictable and such initiatives require enough understanding regarding platforms and ecosystems to create comprehensive data strategies in companies. APIs should be considered as they are becoming increasingly relevant across industries, by either regulation or by choice, and a proper API strategy could be crucial to tap into external strategic opportunities.

External Strategic Opportunities—By external strategic opportunities, we mean that companies are exploiting business opportunities developed beyond company boundaries, typically developed by any third party. According to the interviews, exploiting these external strategic opportunities is an increasingly attractive proposition for companies, but very few have the necessary capabilities and knowledge to integrate them into their strategies yet. These new types of relationships between several contractual parties can be described as follows: several sources of data and several outputs. These types of contractual arrangements seldom exist in industrial supply chains.

The external strategic opportunities continue to remain largely theoretical and superficial—aside from a few examples—but in principle, they stem from the opportunities enabled by product modularity through software, and from complementary innovations (Garcia-Swartz & Garcia-Vicente, 2015; Parker & Van Alstyne, 2005).[6] Although not discussed from these lenses, literature exists on collaborating with externals (Tapscott & Williams, 2006) and on complementary innovations in traditional industries (Peppard, Edwards, & Lambert, 2011), more notably in platform business (Parker, Van Alstyne, & Choudary, 2016; Parker, Van Alstyne, & Jiang, 2016; Zhu & Liu, 2018) and the distributed governance of multi-sided platforms (Hagiu, 2014; Mattila & Seppälä, 2018; Tiwana, 2014).

The types of data resources companies can treat as proprietary and shared is now being partially answered. As the study demonstrated, companies have been efficiently sharing and exchanging data with each other for years, and with proper implementation, can extend data sharing from operational data and processes to other industrial data and external workflows,[7] evaluating the monetary value of external strategic opportunities, i.e., indirect network effects are missing from widely accepted business case valuation methods. As in other fields of study, it is important to address the historical background of any perceivably novel phenomenon to understand how past learnings could be leveraged in the emergence of a new paradigm.

The techno-economic trajectory of data sharing

Historically, many of the benefits related to data—and the underlying mechanisms—have been present in other forms. Recent technologies have enabled product modularity to move from the hardware, such as machines and computers (Henderson & Clark, 1990; Schilling, 2000), to the services and content of the products as outlined by Yoo, Henfridsson, & Lyytinen (2010) and Ghazawneh & Henfridsson (2010). Voss & Hsuan (2009) expanded modularity from product systems to service systems and argued that efficiencies of modularity can also be realized in service processes, and recently, the discussion has shifted to platform modularity (Gawer, 2014; Gawer & Cusumano, 2008). To illustrate the change, personal computers are physically modular (various components, e.g., graphics cards, can be manufactured by anyone and attached to the computer via standard connections) and modern smartphones' configurations are modular via software (every person can have a smartphone that it specifically tailored to the user's needs by installing the specific applications and software modifications desired). The software modularity discussion is now closely tied into a platform-centric discussion because the physical products can create platforms and ecosystems around them attracting external parties to develop these software modules (Gawer & Cusumano, 2008; Katz & Shapiro, 1994; Tiwana & Konsynski, 2010; Tiwana, Konsynski, & Bush, 2010).

To facilitate the cooperation and coopetition, boundary resources have to be set to enable the third parties to use in their development (Gawer, 2009; Ghazawneh & Henfridsson, 2010). When addressing the role of data in firm performance, the companies' data sharing technologies and mechanisms act as boundary resources, as they serve as the interface between the company and the application developers (Ghazawneh & Henfridsson, 2010).

From a technology standpoint, ample literature exists on various information technologies and their impact on firm performance; the benefits enabled by adopting EDI technologies that allowed instantaneous information and data sharing within companies and with external parties (Arunachalam, 1995; Mukhopadhyay et al., 1995; Pfeiffer, 1992), how the integration and adoption of web-based systems enabled even further benefits (Huang, Janz, & Frolick, 2008; Stefansson, 2002; Zhu et al., 2006), and how the emergence of APIs—interfaces that allow thousands of networked systems to communicate with each other in real time—and the related "API economy" (Moilanen et al., 2019) have disrupted businesses and created new opportunities altogether (Jacobson, Brail, & Woods, 2011; Smith, Ofe, & Sandberg, 2016).

From physical to software modularity

Modularity has progressed from physical products to services, and furthermore into software platforms. This has made the realization of its benefits more easily accessible to a wider range of companies, and it is largely driven by the evolution of information technologies as interfaces. Modular product design stems from an article by Starr (1965) in which he proposes a new definition of modular products that are designed as a set of independent modules that can be reused and interchanged to maximize product variety. Literature suggests that modular product design has a positive influence on the products' performance; Antonio, Yam, & Tang (2007) show that product modularity influences the capabilities of delivery, flexibility, and customer service, of which the first two positively relate to product performance. Originally, product modularity was associated with hardware components of various machines and computers (Henderson & Clark, 1990; Schilling, 2000), but with the advancement of information technologies, modular product design has—following a layered architecture model by Yoo, Henfridsson & Lyytinen (2010)—moved from the devices to services and content as well. While Sanchez & Mahoney (1996) use aircraft, automobiles, and consumer electronics as prime examples of product modularity, Gawer & Cusumano (2008) and Tiwana & Konsynski (2010) refer to product modularity in the context of platforms and software modularity, supporting the evolution from device layer to content layer.

Before platform modularity became the focus of the modularity discussion, some researchers, such as Voss & Hsuan (2009) and Tuunanen & Cassab (2011), also examined service modularity. Services are obviously very different from physical products, and interfaces in modular service design can be, e.g., people and information (Voss & Hsuan, 2009), and it can generate market impact efficiently through innovative offerings by reusing and varying existing services (Tuunanen & Cassab, 2011). In service business, modularization can also significantly reduce transaction costs among key actors (Rajala et al., 2019).

Modular design is currently interconnected with platform literature—Gawer (2014) outlines three types of platforms; 1) internal platforms, which have closed interfaces for use within the company, 2) supply chain platforms in which interfaces are selectively open for partners in the company's supply chain, and 3) industry platforms, which have open interfaces available to all external parties. Modular design in the platform's technological architecture is key to exploit the capabilities accessible through the external parties (Gawer, 2014). Tiwana (2008) proposes that modularity decreases the need for control and actually increases performance in alliances, using Amazon and Google as examples[8]. IT modularity also increases IT agility as the systems are more interoperable and easier to integrate (Tiwana & Konsynski, 2010). In essence, a software platform on a product or a service allows external parties to develop and distribute value-adding modules to the platform with very little friction, which can significantly increase the value of the initial product.

Boundary resources and interfaces as enablers

In the data sharing context, interfaces and technologies enabling the transmission and sharing of data can be considered technological boundary resources (as discussed by Ghazawneh and Henfridsson, 2010) through which companies can collaborate with each other. The foundation of boundary resources stems from sociological studies where Star and Griesemer (1989) introduce a "boundary object" as a theoretical tool for conceptualizing how various actors with conflicting objectives can cooperate in a project. Examples of boundary objects are shared repositories, ideal types, coincident boundaries, and standardized forms (Star & Griesemer, 1989).

In the context of software platforms, Ghazawneh and Henfridsson (2010) define "boundary resources" on the basis of boundary objects—they are software tools and regulations that serve as the interface between the platform owner and the application developers. Furthermore, boundary resources can be broken into social (e.g., incentives, intellectual property rights, guidelines) and technological (e.g., software development kits, application programming interfaces) (Gawer, 2009; Ghazawneh, 2012). In this study, the assessed interfaces are considered as technological boundary resources that facilitate the data exchange between companies.

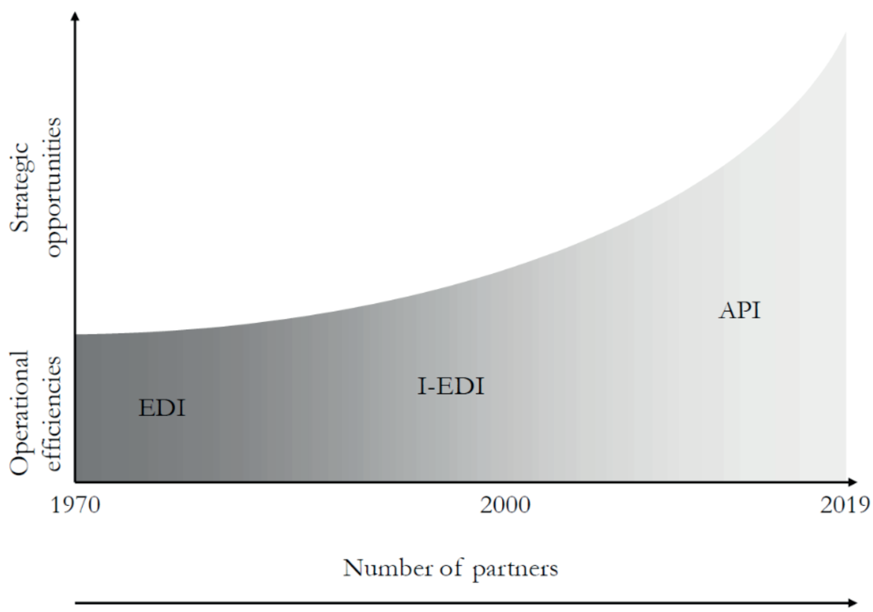
When discussing data and their benefits, the first data interfaces date back to 1970s and have been developed ever since. Figure 2 illustrates how the development of these technologies has enabled companies to tap into increasingly significant benefits.

In the following sections, the business impact and benefits of these technologies will be discussed using both academic literature as well as commentary from Finnish experts.

EDI

Electronic data interchange (EDI) systems trace back to 1970s, and they are a type of interorganizational information system (IOS) (Takac, 1992) that firms or organizations use to exchange information and data within

Figure 2 The development of interfaces has enabled more benefits for companies



or between each other electronically (Narayanan, Marucheck, & Handfield, 2009). They were essentially the first information technology systems that connected companies to each other and allowed the exchange of information and data before the internet without manual labor (Mukhopadhyay et al., 1995).

Before the adoption of the internet, interorganizational information technology systems were primarily used by large corporations who had the resources and the capabilities to adopt EDIs to effectively share operational information within their supply chains (Takac, 1992). General use cases of EDI discussed in the literature (Arunachalam, 1995) include ordering and paying for goods from suppliers, arranging transportation with carriers, receiving orders from customers, invoicing customers and collecting payments from customers—all cases in which information was previously transferred manually, e.g., via a telephone. Interviews with experts echo these findings in modern days; EDIs, much like other information technology systems, were indeed adopted to make various processes significantly more efficient. The benefits resulted in significantly more efficient supply chains, e.g., via mitigating the 'bullwhip effect,' (Lee et al., 1997) as well as more efficient internal operations (Mukhopadhyay et al., 1995; Takac, 1992).

However, their use was somewhat limited as they were implemented to fulfill a specific need or use case—Postipankki, the Finnish bank, integrated an EDI connection in 1985 with the central bank in Europe to have access to real-time currency exchange rates. No interviewees indicated that the EDI systems, or the related data sharing, had any other objectives than to perform something more *efficiently,* i.e., to reduce costs in a one-to-one relationship previously handled manually, e.g., via a telephone.

EDI systems are still used in some functions in corporations. Almost 15% of Finnish companies with more than 10 employees still received EDI orders in 2016[9]—likely the largest companies have legacy IT systems that rely on these connections with the partners. However, some of these reported EDI uses might be associated with I-EDIs, which are discussed below.

Internet-based EDIs

Internet-based IOS technologies started appearing with the widespread adoption of the internet in the late 1990s, and the internet provided a new technology for doing EDI (Stefansson, 2002). These technologies were introduced to upgrade or substitute traditional IOS systems, such as VAN-based EDIs, and they were adopted quite quickly—in 2000, 46% of the 50 Fortune 1000 firms surveyed planned to use internet EDI (I-EDI) in one form or another (Huang et al., 2008; Stefansson, 2002). Fueling the adoption, the I-EDIs were capable of tackling most of the barriers to EDI adoption companies perceived around 1995 (Arunachalam, 1995), of which, most importantly, the average costs of adoption of EDI systems decreased from $100,000 to $10,000 due to not having to set up proprietary connections (Werner, 1999). In Finland, approximately half of all companies were transacting via web-based technologies already in 2009, while the respective EDI penetration remained at 13%. Additionally, during 2008–2012, the penetration of internet-based automated data exchange grew at 10% p.a., while the penetration of EDI-based automated data exchange declined slightly (for more details see "About the Research" p. 4).

In the literature, I-EDIs can be defined as the kind of interorganizational systems that use open standards (e.g., TCP/IP[10] as the communication protocol and XML[11] as the data standard) and are built upon the open internet for information exchange and business-to-business transactions (Zhu et al., 2006). For example, extranets were used by a company and its business partners by allowing external parties access to the company's internal information systems (Stefansson, 2002; Watson, 1999).

The internet allowed the data sharing to reach new levels altogether as the networks of linked parties grew—due to the low adoption costs, even small companies were able to leverage the benefits of EDIs and simultaneously strengthen the network as well. Additionally, the adoption of standardized data formats allowed companies to set up new data streams with much less effort, as additional integration was much simpler when their current systems were already able to interpret the messages. Moreover, the increased integration with third parties with these technologies—particularly in the supply chain network—created some strategic opportunities for the companies that were able to exploit the systems to their full potential (Auramo, Kauremaa, & Tanskanen, 2005).

The easier integration also meant connecting to other parties via the standardized interfaces and starting to enable more sophisticated business benefits. For example, Finnair started utilizing weather data in its forecasts when it became easily available over the internet. Hence, the emergence of advanced analytics in business decision-making and forecasts was greatly accelerated with the availability of more holistic data. Nevertheless, the interviews suggest that such software integrations were largely opportunistic after the adoption of the internet—the main reasoning for the adoption was the ability to exchange, e.g., documents and invoices, with little manual labor, similar to the reasoning of EDI adoption.

The study concludes that the main reasons for adopting extranets or any internet-enabled interorganizational information systems were driven by the more *efficient* operations both within the companies as well as in collaborating with others (Huttunen, 2019). Some companies saw the opportunity to create new revenues utilizing the new opportunities, e.g., banks offering insurance products on the customers' internet banking sites—a tangible example of exploiting some of the first strategic opportunities enabled by the more sophisticated information technologies.

API

Application programming interfaces (API) associated with various types of web services allow developers to easily integrate diverse content (e.g., apps) from different web-enabled systems (Chen, Storey, & Chaing, 2012). APIs can be categorized as boundary resources that external companies can utilize in the development of complementary innovations (Moilanen et al., 2019). Technically, APIs are not drastically different from the other internet-based information systems as they use the same underlying technologies such as XML or JSON[12] over the web (Chen et al., 2012; Huang et al., 2008). However, they differ greatly in their use, while I-EDIs are systems that have web-based connections (e.g., extranets), APIs enable a real-time connection to virtually any service regardless of the system in use. Partly due to the similarity of I-EDI systems, it is a natural evolution that prompts the need for understanding the history of EDI and I-EDI when discussing the APIs.

An additional, but crucial, phenomenon linked to APIs is their connection to big data: the availability of real-time data feeds through APIs that link both public and proprietary data and enables the three Vs (velocity, veracity, and volume) defining big data (Fosso Wamba et al., 2015; Hofmann, 2017). Hence, many of the benefits of big data discussed in the literature are actually contingent on some degree of API integration—having access to big data and being able to extract key insights is increasingly important for companies' competitive edge (Manyika et al., 2011; McAfee & Brynjolfsson, 2012) as it allows companies to make better data-driven decisions that have both strategic (Constantiou & Kallinikos, 2015; Woerner & Wixom, 2015) and operational implications (Addo-Tenkorang & Helo, 2016; Hofmann, 2017).

An expert working in a major Finnish bank explained how proper APIs have become essential to modern software-enabled businesses; companies are increasingly demanding their business partners and service suppliers to provide proper APIs instead of asynchronous data exchange. The real-time data that feed from these APIs are tightly integrated to the company's respective IT systems and are used in a multitude of functions from KPI monitoring to feeding data to estimation models. However, the use of APIs remains largely in such functions; only 6.4% of surveyed[13] Finnish technologically-adept companies reported having an API in their products and services in 2016. Regardless, all interviewees were unanimous about the role of APIs being increasingly prevalent in businesses across industries in the future—missing out on both the operational efficiencies and the potential sales driven by new strategic opportunities could be a major competitive disadvantage if other companies in the industry would successfully integrate their business networks via APIs.

The potential of building business models, products, and services around APIs is difficult to estimate due to the novelty of the issue. However, significant potential is seen in the "API Economy" (Moilanen et al., 2019) and adoption of platform business models in which such APIs and other boundary resources are in crucial roles (Gawer & Cusumano, 2016; Parker et al., 2016; Parker & Van Alstyne, 2018). However, a recent, yet unpublished study, has found a positive relation with opening APIs with increased market value (Benzell et al., 2017)—very little data-driven conclusions aside from this paper exist in the literature as of the time of writing this paper, and many reports rely on logical conclusions and estimates.

Something that has not been addressed in the literature, but came up in expert interviews, is the regulatory push of opening APIs. The European payment services directive (PSD2) is an example of such a regulatory push as it forces banks to open APIs that enable third-party developers access to the essential functions of the incumbent bank to create their own applications and solutions based on the banks' data and platform.

Conclusions and discussion

The advancements in digitalization and information technologies have allowed most progressive companies to monetize new assets by providing software and data platforms on which complementary innovations can be developed. However, publicly available business case tools are missing to build scenarios for value capture of complementary innovations. Hence, the opportunities are closely tied with the notion of product, service and software modularity and boundary resources—a few decades ago, products were developed to be compatible with other hardware, but now, any party can develop new software products and distribute them with little cost.

Product, service and software modularity and boundary resources are partial response to minimize the opportunities for third party hacking. Additionally, modularity and boundary resources have an essential role when contracting for control and data sharing in supply chains and platforms. In contracts, it can be specified who data belongs to, what kinds of access rights there are to the data, whether they are exclusive, parallel, etc. Today the restriction of contract comes, however, from the fact that the contracts in supply chains are not typically made binding on a third party. Eventually, the contracts will define the relative strengths of data control between any parties.

Statistical data in Finland suggest that adoption of data sharing technologies has accelerated with the evolution of technology. This has allowed an increasing number of companies and individuals to contract and take part in the emerging ecosystems due to accelerating network effects. The role of these technologies has been important in enabling companies to realize the benefits of having access to an expanding pool of data—both by having all data internally available and by being able to utilize a large number of data sources and partners simultaneously to build increasingly complex analytics and algorithms. Interviews also highlighted how the reason for the technology adoptions has also changed with time; the EDIs were implemented to make an individual process much more efficient, internet-based systems were adopted for more holistic connectivity and industry-driven peer pressure, and APIs are seen as necessary parts of future business models. Hence, the proposed framework linking technological advancements to benefits remains uncontested.

Managers across industries have likely already recognized the various benefits enabled by having access to sufficient data; costs can be cut by streamlining and optimizing operations and revenues can be grown by being able to predict customers' needs and behaviors. Hence, the internal benefits are already acknowledged, and provided the company has the necessary expertise, they can be brought even further. This study provides examples of benefits companies should be able to expect from sophisticated practices in utilizing the available (or sourced) data and analytics.

The external benefits, both strategic and operational, can only be achieved if the company is willing to share the data externally as well. Operational efficiencies among partners and value chains are already exploited to some extent, as data are shared selectively (e.g., inventory data in supply chains), and hence, cost reductions have been available for some time already. Being able to capitalize on the external strategic opportunities requires companies to share data much more widely and openly—it is risky, however, as the benefits can be unpredictable and such initiatives require sufficient understanding regarding platforms and ecosystems to create comprehensive data strategies in companies. APIs should be considered as they are becoming increasingly relevant across industries, by either regulation or by choice, and proper API strategy is crucial to tap into external strategic opportunities.

While the study has been able to categorize the benefits of data and lay out a motivation for exploring more external strategic opportunities, further research should be put into identifying the levers[14] through which the value is created and captured. Additionally, this study has excluded the discussion around data governance and ownership—it is unlikely that any business would be willing to give free access to all business data, as doing so could potentially destroy their competitive advantage; some framework for categorizing the data and assessing the potential for external access should also be carefully considered.

As history of data sharing shows, industrial data marketplaces are not necessarily needed—companies have been efficiently sharing and exchanging data with each other for years, and with proper implementation can extend it from operational data to other industrial data. As in other fields of study, it is important to address the historical background of any perceivably novel phenomenon to understand how past learnings could be leveraged in the emergence of a new paradigm.

Endnotes

1 We define "digital platform" as "information technology frameworks upon which different actors—i.e., users, service providers and other stakeholders across organizational boundaries—can carry out value-adding activities in a multi-sided market environment governed by agreed boundary resources and objects. Typically, these actors create, offer and maintain products and services that are complementary to one another. Platforms quintessentially lure and lock in various types of actors with their direct and indirect network effects and economic benefits. (See Rajala et al., 2018).

2 Additionally, the information technology adoption costs and other implementation frictions have greatly reduced the cost of technology adaptation (see Huang et al., 2008; Werner, 1999).

3 In 2007, 37% of Finnish companies shared data in their supply chains (companies that employ over ten people); in 2015 -45% (Statistics Finland); in 2019, 49% of Finnish companies that employ over ten people share data (For more information, see Huttunen, 2019, Figure 9: Share of companies sharing information with their supply chain partners, s. 52; Etla calculations).

4 For more information on research methodology and data, see Huttunen, 2019, p. 32–42.

5 Literature from which the model has been derived includes, but is not limited to, efficiencies of adopting interorganizational information systems (Mukhopadhyay et al., 1995; Reekers, 1994), benefits of supply chain information sharing (Cachon & Fisher, 2000; Stevens, 1989; Yu, Yan, & Cheng, 2001), benefits of analytics and data-driven decision-making (Chen et al., 2012; Constantiou & Kallinikos, 2015; Davenport, 2006; Tao et al., 2018), and benefits from complementary innovations (Gawer & Cusumano, 2016; Parker et al., 2016; Parker & Van Alstyne, 2018).

6 There are several perspectives to this: 1) the general competence in understanding the value of complementary innovations for your final customers; 2) the missing model of mapping benefits arising from external strategic opportunities. The current models of mapping benefits have been largely developed for the purpose of internal operational efficiencies and strategic opportunities (see Ailisto et al., 2015; Koller, 1994).

7 For more, see (Mattila, Seppälä, & Lähteenmäki, 2018).

8 Google provides a software platform, Android, which is highly modular, and developers can freely develop applications and modifications to the software. Google has very little control over the developed software, but the platform is very successful.

9 Survey by Statistics Finland.

10 Transmission Control Protocol/Internet Protocol.

11 eXtensible Markup Language.

12 JavaScript Object Notation.

13 Survey conducted by The Research Institute of the Finnish Economy in 2016, n=303 companies that in some way utilize big data in their business.

14 For methods in uncovering value drivers, see, e.g., https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/what-is-value-based-management (1994).

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ETLA

Elinkeinoelämän tutkimuslaitos

The Research Institute of the Finnish Economy

ISSN-L 2323-2447,
ISSN 2323-2447,
ISSN 2323-2455 (Pdf)

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