

# Service Innovation through Application Programming Interfaces - Towards a Typology of Service Designs

Short Paper

**Jochen Wulf**

University of St. Gallen  
Institute of Information Management  
St. Gallen, Switzerland  
jochen.wulf@unisg.ch

**Ivo Blohm**

University of St. Gallen  
Institute of Information Management  
St. Gallen, Switzerland  
ivo.blohm@unisg.ch

## Abstract

*In recent years, many firms have published public Application Programming Interfaces (APIs). However, firms struggle with how to successfully implement API-enabled service innovation. APIs are either boundary resources through which platform strategies are enacted or they represent distribution channels for software, data, or infrastructure. We use a service innovation framework to integrate ten elements that determine business-oriented API design and that were discussed by prior API research. We report the preliminary results of a cluster analysis of 96 randomly sampled and qualitatively coded APIs. We identify three archetypes of API-enabled service innovation that are characterized by distinct configurations of API elements. We use a measure of API popularity to find structural differences of the archetypes' market impact. With our planned research addressing the interplay of API design, ecosystem-based value creation strategies and API performance, we intend to contribute to theory that explains the impact of API design on digital innovation.*

**Keywords:** Application programming interface, web service, service innovation, digital platform, cluster analysis

## Introduction

Since the emergence of first public application programming interfaces (APIs) in the early 2000s that were published by ecommerce providers such as *ebay* and *amazon*, the developer community sees an exponential growth of publically available APIs (Vukovic et al. 2016). Today the directory *ProgrammableWeb* has registered over 18,200 APIs that are available over the Internet from a wide range of institutions and market sectors. While APIs have early been recognized as a service-oriented paradigm that improves architectural efficiency and agility (Cois 2015), API providers realize more profound transformations of their business models. *Salesforce*, for example, operates over 60% of its customer traffic on APIs (Johnson 2013). But companies regard APIs not just as another distribution channel for software applications and data. APIs have turned into an instrument of business strategy (Jacobson et al. 2011). In 2015, *Expedia* generated 90% of its revenue through APIs that allow third-party websites to tap into its travel booking functionality; *ebay's* APIs that list auctions on other websites and allow bidders to automate activities were credited for 60% of *ebay's* revenue (Iyer and Subramaniam 2015c). One reason for the strategic role of APIs is the potential of third-party API developers to become powerful complementors that increase the value of an API provider's platform with value-added services and extend the reach of an API provider's platform into new and at times unforeseen markets (Iyer and Subramaniam 2015a). In tackling API-driven business transformations, API providers must externalize their resources, establish co-opetitive relationships with API developers and enter into competition with

other API ecosystems (Vukovic et al. 2016). APIs enable new modes of value-creating corporate alliances in service ecosystems “revolutionizing traditional business alliances and partnerships through scalability, flexibility and fluidity” (Iyer and Subramaniam 2015b, pg.4). Many firms, however, struggle heavily with how to innovate their service offerings by creating and positioning themselves in service ecosystems that are founded on APIs (Yegge 2011).

In general, APIs are machine readable interfaces that connect multiple applications, provide methods to govern application interaction and establish communication between applications without the need to know the inner workings of how an API’s functionality is provided (Jacobson et al. 2011). A main distinction regarding APIs is whether or not they are publicly accessible. *Closed* APIs offer software functionalities to applications within a company or company network (Mueller et al. 2010). By contrast, *public* APIs, the focus of our research, are accessible from outside of a company’s network via the Internet. They frequently use web protocols and, thus, represent web services (Curbera et al. 2003). The business-oriented literature on public APIs discusses business models (e.g. Evans and Basole 2016; Legner 2009; Nuettgens and Iskender 2008), platform strategies (e.g. Eaton et al. 2015; Ghazawneh and Henfridsson 2013), pricing (Weinhardt et al. 2011; Zimmermann et al. 2016) and performance impacts (Benzell et al. 2016). Yoo et al. (2010) acknowledge the importance of APIs for digital innovation and call for further research on how the design of APIs affect a firm’s strategic positioning. Prior API literature selectively discusses several design elements, but lacks a theoretically motivated unifying framework that describes design choices for public APIs and their interrelationships. We address this research gap and respond to the call of Yoo et al. (2010) by conceptualizing and empirically validating a typology of API designs. In our future research, we will use this typology to study the interplay of API design, value creation strategies in digital ecosystems (Gawer 2014) and API performance (Benzell et al. 2016; Sosa et al. 2004; Tiwana and Konsynski 2010).

In this research-in-progress paper, we present preliminary results of a cluster analysis of 96 APIs randomly sampled from the ProgrammableWeb API directory. We use prior literature to derive ten API design elements and, based on a coding of these elements and cluster analyzes, identify three archetypes of API-enabled service innovation. Further, we use a measure of API popularity to find structural differences in the market impact of the three archetypes. We discuss further research steps and our planned contributions to the literature streams on APIs and digital platforms.

## Conceptual and Theoretical Foundations

### ***Related Work: Business-oriented API Literature***

Services consist of value-adding activities of resource integration that are provided by multiple actors and customers in a value creation system (Lusch and Nambisan 2015). The disintegration of a companies’ value creation activities and an IT-enabled resource re-aggregation in service ecosystems spurs service innovations in many industries (Barrett et al. 2015; Fishenden and Thompson 2013) and APIs represent important enablers of this transformation. For instance, in the enterprise software market, software vendors and software service providers form software ecosystems and flexibly interconnect their software components via APIs (Jansen et al. 2013). APIs not only support operational networks for service delivery, but also represent vehicles for service innovation (Rohrbeck et al. 2009). By providing access to internal software resources, API providers foster interaction with partners and external developers and gain innovation capacity. Examples comprise mobile service ecosystems (Boudreau 2010) and open data ecosystems (Lindman et al. 2013).

APIs often provide technological interfaces to digital platforms and, thus, represent boundary resources through which digital platform strategies are enacted (Dal Bianco et al. 2014; Ghazawneh and Henfridsson 2013). Digital platforms consist of an extensible codebase for a core functionality and interfaces such as software development kits (SDKs) or APIs. These interfaces connect add-on software subsystems, i.e., applications that are provided by third party developers and add functionality to the platform (Tiwana et al. 2010). Digital platforms serve as network effect markets on which APIs facilitate the interactions between the platform owner, its customers and potentially also third party developers (Eisenmann et al. 2011; Tiwana et al. 2010). APIs may enable interactions between third party developers and customers by making platform-based marketing resources available to developers (Selander et al. 2013).

Alternatively, APIs serve as distribution channels – without connecting add-on software subsystems. For example, data aggregators use APIs for distributing their data services (Hartmann et al. 2016) or for streaming data to customer applications (Pigni et al. 2016). As a second example, cloud service providers use APIs to provide access to applications and infrastructure (Lin and Chen 2012).

Whether and how the design of APIs bears strategic importance for digital innovation is an open research question (Yoo et al. 2010)(2010). Addressing this question, we aim to close two research gaps. First, prior business-oriented API literature discusses selective API elements without proposing an overarching theory that explains the choice of and structures the different API elements. As examples, Ghazawneh and Henfridsson (2013) apply a boundary resources model that focusses on practices of resourcing (enhancement of a platform) and securing (increasing platform control). Nuettgens and Iskender (2008) adopt a business model perspective and focus on API providers' market and revenue models. Zimmermann et al. (2016) use real options theory to model API revenues and costs. In summary, prior business-oriented API literature focusses on different aspects of API design but lacks an overarching theoretical perspective that structures and unifies these API elements that carry potential strategic importance for digital innovation.

Second, prior API literature discusses several API strategies at the macro-level (e.g. Evans and Basole 2016; Legner 2009; Nuettgens and Iskender 2008) but lacks an analysis of how interrelated choices in API design on a micro-level support these strategies. Service innovation literature suggests that the alignment of API elements, rather than single element designs, determines the formation of stable service archetypes (Hertog 2000). This is because processes of service delivery and service offering closely interact in service provisioning. With regard to APIs in digital platforms, prior literature suggests – yet not empirically validates - that design choices related to platform architecture and governance need to be aligned (Tiwana 2015; Tiwana et al. 2010). In summary, various authors imply the existence of API archetypes, the conceptualization of which would facilitate addressing Yoo et al.'s (2010) call for research on API design and effects on digital innovation. Prior API literature lacks empirical accounts of interrelated API design choices on the micro-level.

### ***Theoretical Lens: API as Instrument for Service Innovation***

Hertog (2000) introduces a framework to analyze service innovations and proposes four interrelated dimensions: new service concept, new client interface, new service delivery system and technological options. The *service concept* describes the novel idea of how to design a solution to a problem. Novelty may equally refer to the providing firm, the client, the regional market or to the service logic. The *client interface* specifies the way a provider interacts with a client. Since, in services, clients are actively involved in co-producing a service, customer interaction is a stronger source of innovation than for tangible goods. The *service delivery system* describes the internal organizational arrangements that coordinate the interworking of parties involved in service provision. It characterizes the roles of the individual actors and the rules that govern interactions. The *technological options* dimension refers to the role of technology for service innovation and describes how technology facilitates or enables the other innovation dimensions. Hertog's service innovation framework has been used by various IS researchers as a conceptual basis for IT service innovations (e.g. Barrett et al. 2015; Saarikko 2016). Based on Hertog (2000), we consider API-enabled service innovations to consist of orchestrated API design choices in the dimensions of service concept, client interface, service delivery and technological options. The extant IS literature provides insights regarding individual API elements that are potentially relevant to API-enabled service innovation.<sup>1</sup> These API elements are summarized in Table 1 and discussed in the following.

In the *service concept dimension*, it is common to extend a software product by an API in order to strengthen the original core business (Nuettgens and Iskender 2008). Providers offer APIs as an alternative access channel. They enable access to software-based services that are distributed as software products or to data published on a website. Further, they facilitate the integration into customers' systems landscapes (Legner 2009). We call this element of an API's service concept *multi-channel access*. A

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<sup>1</sup> In order to identify API elements, we searched in the AIS Senior Scholars' Basket of Journals for mentions of the term application programming interface and synonyms. We selected those journals that contain discussions of API design and conducted forward and backward searches to find further articles.

second design choice is to provide a function or data. The API element *function* refers to an API's support of a transition from an initial state to a goal state (Umapathy and Puro 2007), such as the facilitation of business process execution (Zimmermann et al. 2016). Alternatively, APIs provide data-as-a-service by allowing access to proprietary and aggregated data or infrastructure-as-a-service (Hartmann et al. 2016; Lin and Chen 2012; Yoo et al. 2010). A third design choice related to the service concept reflects pricing. APIs can serve as direct source of revenue (Zimmermann et al. 2016). In this regard, existing research has identified three different pricing schemes: *transaction-based* and *subscription-based* charges (Nuettgens and Iskender 2008) or free of charge data access when none of these schemes apply (Evans and Basole 2016).

Regarding the *client interface dimension*, APIs can be designed as a distribution channel that connects developers with end customers. APIs then provide access to an end customer-facing platform. They allow developers to exploit platform-based marketing resources (Benlian et al. 2015; Selander et al. 2013) and to offer value added services to the platform's installed customer base, e.g., by extending applications to new operating systems (Lee et al. 2010). We call this feature *end customer access*. A second design element reflects *user authorization* which is the process of granting permission for an activity and represents a functional component in API standards (Gosain 2007, p. 56). Since APIs allow access to a company's internal resources, API providers must protect their strategic assets while they must encourage developer innovation at the same time (Tiwana et al. 2010). Authorization allows API providers to execute tight control (Benzell et al. 2016). Alternatively, API providers may go without authorization in order to decrease adoption barriers, e.g., in the case of open data (Lindman et al. 2013).

In the *service delivery system* dimension, APIs can enable developers to make products that are complementary to the API provider's offerings (Benzell et al. 2016). APIs position third-party modules to fill holes in the API provider's product line (Ghazawneh and Henfridsson 2011) or to innovate value-adding functionality to an API providers' platform (Tiwana et al. 2010). We call this API element *product complementarity*. Second, API providers can use *revenue sharing* to attract API developers with the goal to enrich an API provider's product offering (Benlian et al. 2015; Jansen et al. 2013). For example, the appropriation of value between providers and developers through revenue sharing represents a key success factor for offering a wide portfolio of services in mobile ecosystems (Oh et al. 2015).

In the *technological options* dimension, APIs can allow secure communication by using message encryption standards (Gosain 2007). Security risks such as data leakage or loss of data are among the most important barriers for adopting cloud services (Lin and Chen 2012). The API element *security* thus characterizes an API provider's investments into function assurance by implementing encryption mechanisms. *Connection type* reflects a second API element in this dimension. It specifies how the connection between API provider and its API consumers is managed (Umapathy and Puro 2007). One approach that is referred to as *data streaming* maintains an open connection over a longer time and delivers new data as it is received by the API provider. Alternatively, a connection is closed right after a full response is received by the API consumer. Data streams have the potential for API consumers to improve real-time decision making (Pigni et al. 2016) but also require new infrastructural and organizational capabilities (Anand et al. 2016).

## Methodology

In this short paper, we triangulate several data sources and research methods in order to investigate archetypes of API-enabled service innovations. Our empirical base is a snapshot of the ProgrammableWeb API Directory from March 2016, the Internet's most complete account of information regarding public APIs (Evans and Basole 2016; Yu and Woodard 2008). The API directory contains self-reported data of API providers that can list their API(s) in the directory and describe it according to pre-defined criteria such as category, architecture and type as well as provide other related information such as technical documentations for developers. Second, ProgrammableWeb collects information about how developers engage with certain APIs. Developers can follow APIs such that they are provided with news and other updates regarding these APIs or provide information that they use an API in one of their applications.

In order to develop a preliminary taxonomy of API-enabled service innovations, we randomly sampled APIs and verified for each API whether it was still maintained by the respective API provider in March 2017 and, for stability reasons, was in the market for more than one year. We considered a total of 96 APIs

for further data collection. Based on our review of the API and service innovation literature, we derived ten API elements that potentially characterize API-enabled service innovation. We applied content analysis to the corresponding API websites, their technical documentations as well as their terms of use/services. Our central study variables are reflected by ten dichotomous variables representing API elements. These variables indicate whether a certain element is implemented by an API provider or not (0 = no implementation, 1 = implementation). In order to ensure reliability of the content analysis, all APIs were coded by two researchers. The intercoder reliability was checked using Cohen's Kappa that exceeded a value of 0.82 which indicates excellent agreement (Landis and Koch 1977). Following Malhotra et al. (2005), we used an additional variable describing API popularity in order to judge the plausibility of our results and give insights into market impact of different types of API-enabled service innovation. More precisely, we used a measure provided by ProgrammableWeb in order to assess API popularity. In line with existing research, we considered an API's *number of followers* as this reflects the potential number of developers that are interested in information updates regarding the API (Bianchini et al. 2013; Parker et al. 2017; Zadeh and Sharda 2014). Also, we investigated whether the API providers' original services that are enhanced by means of an API primarily target end consumers or other businesses.

We identify archetypes of API-enabled service innovations by applying cluster analysis. Cluster analysis groups entities such that the in-group variation is small in relation to inter-group variation (Malhotra et al. 2005). By defining distinctive variables (i.e., API elements), cluster analysis groups entities (i.e., APIs) according to their reciprocal similarities and distances describing natural groups (Leisch 2006; Rendón et al. 2011). In order to avoid idiosyncratic errors specific to a certain clustering technique, we used different cluster algorithms applying distinct similarity and distance metrics. In particular, we used Ward's algorithm and K-Means clustering as they produce accurate clustering with smaller data sets (Gong and Richman 1995), are able to deal with dichotomous data (Finch 2005; Leisch 2006) and are widespread clustering techniques (Malhotra et al. 2005; Provost and Fawcett 2013).

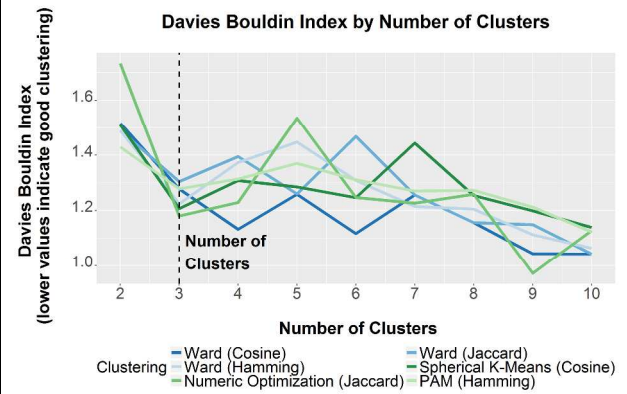
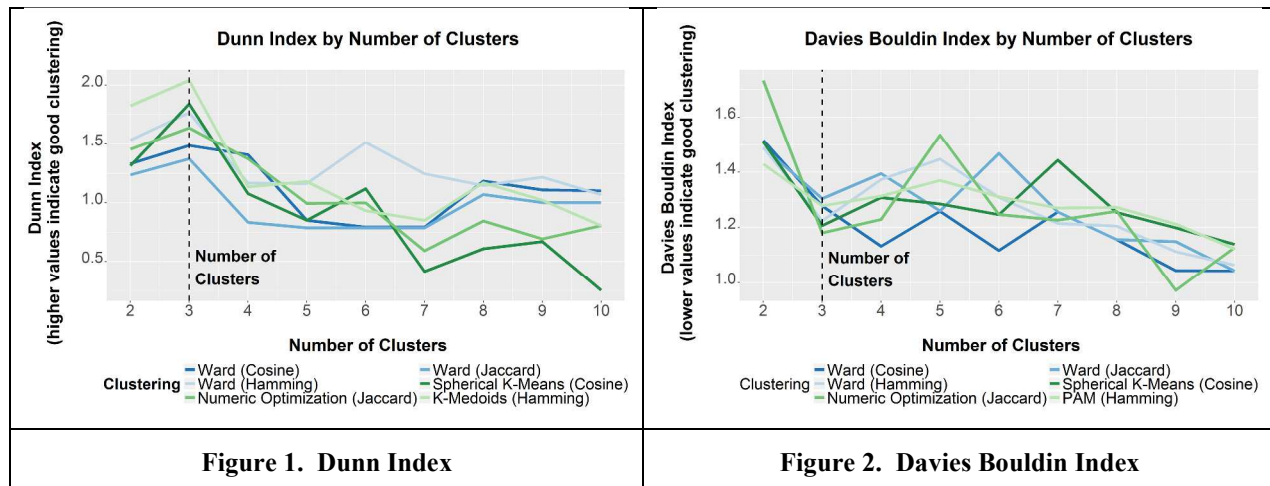
## Preliminary Results

### *Cluster Analysis*

All clusterings and calculations have been done with the R language and environment for statistical computing.<sup>2</sup> The cluster analysis indicates a robust three cluster solution that can be clearly interpreted (see Figure 1 and Figure 2). All clustering approaches produce similar results. We report results for the Spherical K-Means clustering using cosine similarity only (Hornik et al. 2016). Based on our theoretical considerations, the implementation of an API elements reflects a conscious design decision of an API provider. Following this line of reasoning, cosine similarity has the conceptual beauty that it is an asymmetrical similarity measure and, thus, takes into account such conscious design decisions only (Foreman 2013). By contrast, other applicable similarity and distance measures also take into account non-implemented API elements for which we cannot infer conscious design. After validating the cluster structure, we conduct descriptive analysis using cross tabulation and contingency analysis to characterize the clusters that can be considered as archetypes of API-enabled service innovation. As the cluster variables indicating the attribution of APIs to the clusters are nominal, we calculate Cramer V's to test whether or not the API elements significantly differ across clusters. We analyze global differences across all clusters and then apply post-hoc tests, comparing single clusters. In order to ensure that the analysis represents a realistic picture of API-enabled service innovations, the assignment of APIs to clusters was manually verified for plausibility (Malhotra et al. 2005). Table 1 gives an overview of the clustering results.

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<sup>2</sup> We used the R packages "skmeans" (Hornik et al. 2016), "flexclust" (Leisch and Dimitriadou 2013), "cluster" (Maechler et al. 2016), "clusterSim" (Walesiak and Dudek 2015) and "fpc" (Henning 2016).



## API Archetypes

The *Integrator* cluster primarily describes API-enabled service innovations, in which API providers create an API that enables their clients to integrate the functionality of the API provider's offerings directly into the client's existing information systems and the evolving business operations. About 60% of these APIs do not only provide data, but also offer more sophisticated information processing functionalities. These APIs are frequently built to leverage an already existing service or product of the API provider for which the API usually represents an alternative access channel. For instance, Salesforce offers an API with which its customers can integrate the functionalities and the data of the customer relationship software directly into already existing enterprise systems. A similar approach is followed by *Scoop.it!*. Access to these service models is usually provided by a subscription- or transactions-based pricing scheme. Consequently, these APIs make extant use of user authorization and security approaches.

*Free Data Providers* apply APIs in order to open up their data vaults. These APIs make no use of subscription or transaction-based charges. Consequently, they offer free-of-charge data access without offering extant information processing functionalities. In 90% of the cases, the APIs are offered as an alternative channel to a website such that these APIs intend to establish effective multi-channel access. The primary reason behind these API-enabled service innovations is reflected by the goal of involving the general public in approaches of open innovation. For instance, *wine.com* provides an API with which it provides developers access to its catalog of wine and other wine-related data. Developers are explicitly allowed to use the API for commercial purposes such that they may potentially develop innovations that drive sales in the *wine.com* online store. Similarly, approaches are pursued by the *New York Times* for providing journalists with better data access or the *Australian National Library* for providing more efficient access to its digitized content. As consequence of these open approaches, Free Data Providers apply less rigid user authorization and security regimes when compared to APIs of the other two clusters.

API-enabled service innovations that follow a *Mediator* approach intend to build an ecosystem around an existing service using APIs. However, as opposed to APIs in the other two clusters, Mediator APIs focus less on establishing multi-channel access. By contrast, all investigated APIs offer extant information processing functionalities based on which API developers can develop new services offerings for the API providers' end customers. Consequently, the majority of API providers following a Mediator approach offer direct access to their customer base. For instance, *Facebook* offers an API with which developers can create complimentary applications in order to provide new services and offerings for Facebook's installed user base, i.e. Facebook apps and games. Similar offerings are made by *Amazon* or *LinkedIn* – APIs that allow publishing information or developing end user applications that are then offered within the boundaries of these networks. API providers usually do not apply transaction- or subscription-based charges such that these APIs can be used free-of-charge. User authorization and security measures are frequently applied

However, we found no significant differences between the three archetypes in regard to the focus of the API providers' original services. Thus, B2B and B2C models are evenly distributed across the three archetypes.

Table 1. API elements, definitions, guiding references and clustering results									
ID <sup>1)</sup>	API element	Definition and guiding references	Cluster <sup>2)</sup>			CV <sup>6)</sup>	Post-hoc tests		
			Integrator <sup>3)</sup>	Free Data Provider <sup>4)</sup>	Mediator <sup>5)</sup>		1-3	2-3	1-2
Service concept	Multi-channel access	Functionality or data is accessible through alternative channels (Legner 2009; Nuettgens and Iskender 2008)	79	90	46	0.37 ***	***	***	*
	Function	API carries out information processing task (Hartmann et al. 2016; Umapathy and Puro 2007; Zimmermann et al. 2016)	60	15	100	0.59 ***	***	***	***
	Subscription-based charge	API users are charged by subscription-oriented logic (Legner 2009; Nuettgens and Iskender 2008; Zimmermann et al. 2016)	90	5	0	0.88 ***	***	***	***
	Transaction-based charge	API users are charged for volume of data or transactions (Legner 2009; Nuettgens and Iskender 2008; Zimmermann et al. 2016)	85	0	0	0.85 ***	***		***
Client interface	End customer access	API links developers to end customers (Lee et al. 2010; Selander et al. 2013; Tiwana et al. 2010)	10	15	75	0.62 ***	***	***	***
	User authorization	API supports user authentication (e.g. key or token based) (Gosain 2007; Lindman et al. 2013)	98	75	92	0.32 ***			**
Delivery system	Product complementarity	APIs position third-party modules as functional add-ons to API provider's offerings (Benzell et al. 2016; Ghazawneh and Henfridsson 2011; Tiwana et al. 2010)	0	0	92	0.94 ***	***	***	
	Revenue sharing	API provider shares revenues with developers (Benlian et al. 2015; Jansen et al. 2013; Oh et al. 2015)	4	10	0	0.17			
Technology	Security	API supports data encryption (e.g. HTTPS) (Gosain 2007; Lin and Chen 2012)	85	30	79	0.48 ***		**	***
	Connection type	API provides continuous stream of data (in contrast to a discrete result) (Anand et al. 2016; Pigni et al. 2016; Umapathy and Puro 2007)	2	0	0	0.09			

1) Service innovation dimension, 2) Percentage of APIs in one cluster that have implemented a given API element, 3) N= 52, 4) N= 20, 5) N= 24, 6) Cramer's V, \*\*\* p ≤ 0.01; \*\* p ≤ 0.05; \* p ≤ 0.1

### API Popularity

In order to approximate the market impact of these archetypes of API-enabled service innovations, we compare API popularity across the three clusters. However, API popularity is not normally distributed and rather follows a power law distribution (Yu and Woodard 2008). We thus apply a non-parametric Kruskal Wallis Test in order to test for global differences in API popularity and pairwise Wilcoxon Rank Sum Tests for post hoc comparisons. Comparing the mean number of followers between the three types of

API-enabled service innovations shows that Mediators have most followers ( $\mu=180.34$ ;  $\sigma=352.43$ ), followed by Free Data Providers ( $\mu=56.53$ ;  $\sigma=87.06$ ) and Integrators ( $\mu=29.30$ ;  $\sigma=45.11$ ). The omnibus Kruskal-Wallis Test shows that these differences are significant ( $p < 0.05$ ). Post-hoc comparisons reveal that Mediators and Integrators differ significantly ( $p < 0.01$ ), while no difference can be detected between the other clusters.

## **Research Outlook**

In this short paper, we conceptualized APIs as an approach for service innovation that enables organizations to build digital platforms or to distribute data and applications. Our preliminary research identifies distinct API element configurations that we interpret as archetypes of such API-enabled service innovation. Further, we uncover that there are structural differences among the archetypes in API popularity that can be considered as a preliminary measure of API performance on the market.

As next research steps, we will elaborate on the relationship between archetypical API configurations and their performance. Existing literature on digital platforms suggests that there are different platform-based value creation strategies (Gawer 2014). For instance, creating economies of scope in production aims at integrating an API provider's value creation processes with its API customers' value creation processes. The primary intention for offering such an API is to generate and appropriate value from existing internal capabilities and to vertically deepen value creation partnerships with customers. Similarly, platforms can leverage on economies of scope in demand in order to share access to end customers and marketing resources. Thus, API providers may benefit from platform-based services developed by API developers that are complementary to the API providers end customer facing core services. We expect that these value creation strategies moderate the influence of archetype choice on the (perceived) API performance, i.e., the API configuration has to be aligned with the API provider's intended value creation strategy.

In order to test these relationships, we plan to triangulate our data on API element configurations (from the qualitative coding) and popularity (taken from ProgrammableWeb) with a survey among managers in API providing organizations. Consequently, this survey will focus on intended value creation strategies and API performance. In terms of value creation strategies, we will focus on constructs such as economies of scope in production owing to shared production (Gawer 2014; Panzar and Willig 1981; Teece 1982) and linkage effects (D'Aveni and Ravenscraft 1994; Garcia et al. 2007; Gawer 2014), economies of innovation (Eisenmann et al. 2011; Gawer 2014; Parker and Van Alstyne 2005) and economies of scope in demand (Eisenmann et al. 2011; Gawer 2014; Parker and Van Alstyne 2005). Likewise, we use the survey to elaborate on measuring API performance. We will focus on constructs such as the contribution of an API to the financial performance of the underlying service, API-endowed competitive advantages or the usage of the API in terms of calls per day (Benzell et al. 2016; Sosa et al. 2004; Tiwana and Konsynski 2010). Finally, we will include constructs on the perceived extent of direct and indirect network effects (Gawer 2014) and on what types of services are developed by third parties using a given API (i.e., B2B vs. B2C) as this may reflect important contingencies. As far as possible, we will rely on existing constructs that we will adapt to the specific context of this study.

In order to collect data on a representative sample of API providing organizations, we intend to follow a two-pronged approach. First, we will try to survey the managers of the APIs that are investigated within this paper. Second, we will address not yet investigated API providers that are listed in the ProgrammableWeb directory and engage in a second wave of content analyzing APIs. This approach will not only help to ensure sufficient sample size for the final analysis, but also for investigating the temporal stability of our typology of API-enabled service innovation.

## **Intended Contributions**

Though APIs are of high importance for the digital economy, there is a strong need for further research on the strategic role of API design for digital innovation (Yoo et al. 2010). With our empirical research on API-enabled service innovation, we intend two contributions to the extant literature.

First, our preliminary research will enable the study of APIs as a strategic instrument for digital innovation. Existing frameworks that structure elements of API design focus on selected aspects such as API function (Ghazawneh and Henfridsson 2013), pricing (Zimmermann et al. 2016) or tuning (Eaton et



al. 2015) . Using the service innovation model of Hertog (2000), we introduce a broad theoretical framework that integrates and structures the API design elements discussed selectively by prior research. Furthermore, while existing research has considered element design choices as being independent, our cluster analysis exhibits dominant patterns of design choices made in conjecture. Thus, the resulting archetypes of API-enabled service innovations offer a more realistic and empirically grounded understanding that accounts for element interrelationships. In future research, we will be able to link these archetypes of API-enabled service innovations to API performance and market impact by triangulating them with survey data and ProgrammableWeb data.

Second, since many APIs are platform boundary resources (Eaton et al. 2015; Ghazawneh and Henfridsson 2013), we also plan to contribute to the literature on digital platforms. Building on the conceptualization of APIs as interfaces for integrating external resources into existing value co-creation systems that produce and deliver services (Lusch and Nambisan 2015), our planned results extend existing research by exhibiting that distinct choices regarding API design render different types of platform ecosystems. Gawer (2014) develops an integrative framework for digital platforms and proposes that platforms crucially depend on different value creation mechanisms, i.e., economies of scope in supply and innovation as well as economies in demand. Responding to Gawer's (2014) call for systematic empirical validation of her proposed theory, we intend to show that the choice of API archetypes links to the mechanism of value creation on a platform. For instance, *Free Data Providers* offer APIs to spur innovations that leverage the available data assets. We thus expect high economies of innovation. However, developers have to commercialize these innovations on their own by building up a new or using their already installed customer base. By contrast, *Mediators* offer not only resources in terms of functionality and data but also access to their customers. Thus, these API provider mediate the relationship between third party developers and their customer base. Here, we will posit high economies in demand. In ecosystems formed by *Integrators*, platform customers have the ability to develop their own applications for integrating the functionality and the data provided by the API into their information systems and business operations. Here, we primarily expect economies of production owing to linkage effects.

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