Abstract

Digital platforms facilitate interactions across distinct groups of users, gaining value from the number of users adopting it through network effects. A key concern is how to scale the platform’s user base and services. Although studies detail strategies for scaling a platform’s user base, much emphasis is on platforms that exercise proprietary ownership over core platform components. This paper draws on the notion of value-driven lock-ins to understand how platforms scale in ecosystems where control of core components is distributed across multiple actors. To investigate how platform owners, operationalize value-driven lock-ins in scaling platforms in such contexts, we trace resource configurations that facilitate scaling of service innovation from an open API platform. Our findings suggest that a key focus in establishing value-driven lock-ins involves resource configurations that seek to reduce the cognitive distance between platform owners and distributed actors. Ensuring participation in such ecosystems requires trust aligned with progressive access to services.

Keywords

Value-driven, lock-ins, Platform Ecosystems, Platform Scaling, User base, Digital Service Innovation.

Introduction

Digital platforms provide organizations opportunities to create value from the utilization of external resources, services, and external actors (Gawer and Cusumano 2008). While research and practice points to benefits such as cost saving and enhanced competitiveness enabled by platforms (Tiwana 2013), digital platform start-ups often fail to scale i.e. qualitative and quantitative increasing interactions among users and modules that constitute the platform ecosystem (Tiwana 2013). Besides the failure to design an appropriate level of openness, failure to appropriate value or engage with developers using the platform (Van Alstyne et al. 2016a), most literature attributes the failure to scale to the inability of many digital platform start-ups to attract an initial base of users to create value on the platform. Platforms create value by linking distinct groups of users who can interact on a platform to ignite network effects (Evans, 2009). Because the value of a platform builds on the participation and interaction of the user base, neither side of a platform (e.g. app developers) are often willing to participate (e.g. engage in the development of services) without users for services and vice versa (Caillaud and Jullien 2003; Parker et al. 2016b). Thus, a key concern in building the user base of a platform is for the platform owner to engage in efforts that can attract users on both sides of the platform. A key strategy emphasized in the literature involves subsidizing one side of the platform with the expectation that the other side will follow suit (Rochet and Tirole 2003; Eisenmann et al. 2006). Although this strategy seems simple at first sight, its practical implementation builds on the assumptions that (1) the platform owner should be able to lock-in users attracted to the platform, with the expectation that the other side may gradually follow suit, or, (2) expect initial users attracted to the platform to remain committed while the user base on both sides of the platform grows.
gradually. Together, both assumptions largely build on an understanding of a platform as a product or device e.g. game consoles or computer operating systems with a relatively stable core (Baldwin and Woodard 2009) wherein proprietary ownership and control of core component of the platform, enables platform owners to establish control points to create lock-in of users and services based on the platform. However, digital platforms are far much fluid in terms of control to ascertain any substantial lock-in of users. In fact, the existence of a stable core of a platform upon which to ascertain substantial levels of control remains questionable as a platform’s core is said to be an ongoing negotiated balancing act across multiple actors and context (Saarikko 2016).

An alternative strategy available to a platform owner to build the platform’s user base is through value-driven lock-ins. Value-driven lock-ins broadly involves building the platform user base through making the platform valuable for users attracted to the platform to make the option of switching to an alternative platform unappealing (Tiwana 2013, p. 37). Although this approach seems promising and said to be "potentially bountiful in digital platforms" (Tiwana 2013), in practice we understand little about its operationalization in scaling digital platform ecosystems. Against this backdrop, this research seeks to understand how digital platform owners leverage value driven lock-ins to scale digital platform ecosystem? We do so through a case study of an open API platform- Trafiklab. Drawing on Lusch and Nambissan (2015), we conceptualize value-driven lock-ins as resource configurations that platform owners leverage with the overarching purpose to scale a platform through building a common worldview among actors in the ecosystem, enabling structural and integrity flexibility, and, providing an architecture that aligns a network of actors to enable value exchange. Rather than seen as independent from each other, the three dimensions of value-driven lock-ins are not mutually exclusive. However, we suggest there is an inherent sequence among them in building a platform’s user base, starting with (1) resource configurations that seek to developed a shared view across actors in the ecosystem, (2) resource configurations that facilitate interactions to integrate the activities of distributed actors, and (3) resource configurations that seek to extend the platform’s user base and services through enabling an architecture for participation.

Scaling Platform Ecosystem

In broad terms, platforms can be understood as a technology foundation upon which external actors can develop services and create value (Gawer and Cusumano 2008). The underlying technology base of the platform enables distributed actors to generate complementary innovation by leveraging shared assets, designs and standards (Thomas et al. 2014; Cusumano and Gawer 2002). Because platforms are valuable with more users, scaling the platform i.e. increasing interaction among users and functionalities of modules that constitute the platform’s ecosystem is of practical importance. Although the literature on platforms is vast, extant literature addressing strategies related to scaling of a platform can be summarized in three main perspectives, (1) level of openness, (2) Leadership role of the platform owner, and (3) economic incentives on surpassing critical mass. The openness perspective generally focuses on "the degree of access that consumers, producers, and others have to a platform, and what they’re allowed to do there" (Van Alstyne et al. 2016b, p. 2). A central aspect in this body of literature is that a platform with a high degree of openness provides a high options value for users to contribute in developing services (Baldwin and Woodard 2009). The argument being that platforms with high options value i.e. perceived to be open and providing different types of opportunities to create value will likely attract and encourage users to create services (Baldwin and Woodard 2009). Further studies in this line of thinking, have acknowledged that opening a platform to external innovators in itself does not necessarily create value. Rather, understanding how and when platforms can be structured to encourage contribution from external innovators is important in developing an attractive platform (Eisenmann et al. 2008). Literature has thus indicated that as platforms evolve and face competition from rivals, broadening sponsorship of the platform through licensing could attract new providers thereby reducing the cost for managing the platform and widening the user base of the platform (Eisenmann et al. 2008). Given the difficulties in defining an optimal level of openness for the platform, subsequent research suggests that openness to the platform to users such as developers should be a reflection of the proportional value they can generate as the platform evolves (Parker and Van Alstyne 2017).

Related to the openness view, is the platform leadership view which builds on Gawer and Cusumano (2002) and Cusumano and Gawer (2002) seminal work on platform leaders i.e. "companies that drive industrywide innovation for an evolving system of separately developed pieces of technology" (pp. 52). According to this
view, sustaining a platform's competitiveness, requires paying attention to four levers as a platform evolves. These include (1) scope: i.e. deciding how much innovation should be done in-house or left for complementors, (2) decisions about the architecture of the platform, (3) relationship with complementors and (3) development of an internal structure to manage conflicts (Cusumano and Gawer 2002, p. 53). Most literature building on this view draw on concepts such as competence and power that a dominant platform owner could exert to enable control and collaboration across platform complementors (Perrons 2009; Gawer 2015). Seen from this view, a platform owner scales it user base and services through deliberate strategic choices reflecting its capabilities. A platform owner will scale its ecosystem of users and services by attracting users to develop components which cannot be developed in-house due to the lack of competence, while developing in-house components and services it has expertise in (Gawer 2015).

Finally, the network effects perspective is grounded in economic literature viewing the scaling of the platform in terms of surpassing a threshold of adopters to enable the platform to grow exponentially through a self-reinforced loop of network externalities (Katz and Shapiro 1985). Pricing strategies such as subsidies and premium fees are key strategies often deployed to scale the platform (Rochet and Tirole 2003; Eisenmann et al. 2006). For example, subsidizing users on one side of the platform with the goal of reaching a critical mass of users. The main thrust of the network effect builds on the explanation that users derive less value from certain products when consumed in isolation compared to when other users consume similar products (Katz and Shapiro 1985). Thus, a platform is prone to failure if it fails to attract a critical mass of users on the platform. Although these three perspectives differ in terms of focus, a closer examination of the literature, share a commonality in that the platform owner is assumed to exercise substantial level of control on key components of the platform to choose what strategies are appropriate. This characterization of platforms while useful does not provide a thorough understanding of how platforms can be enabled to scale when key components essential for the overall functioning of the ecosystem are distributed across heterogeneous actors with varying degree of control and ownership. In the subsequent section, we address the dynamic nature of digital platforms.

**The Dynamic Nature of Digital Platforms**

Lock-ins can generally be understood as different constraints e.g. switching cost, learning cost, rules, routines, institutions or insignificant events that could propel/impede a technology to emerge as a de facto standard or hinder users of a technology from switching to a viable alternative (Authur 1989). Lock-ins reinforce and are reinforced by path dependency wherein adoption of a technology by potential users relies or is triggered by prior adoption by other users, market conditions or increasing returns associated with using the technology (David 1994; Authur 1989). In a platform context, lock-ins are reinforced by network effects as initial users of a platform spur further users to enroll on the platform, thus setting a beneficial trajectory for the platform. Because platforms rely on the accumulation of a user base, the tendency to scale the platform largely depends on efforts made by a platform owner to sustain a committed base of users attracted to the platform. Thus, when referring to lock-ins in the context of this study, it refers to “ways in which a platform can make it more desirable for existing users to stay put and not jump ship to a rival [or alternative mode of use] platform” (Tiwana 2013, p. 37). In theory digital platforms due to their malleability and generativity (Zitran 2011) can scale easily, as they constitute digital artifacts that can be distributed across different contexts (Kallinikos et al. 2013). The digital artifacts that constitutes such platforms are relatively open in the sense that (1) they can be edited by dispersed users and across use context, and (2) control over their use is subjective to different users, rules, and contexts (Kallinikos et al. 2013). Thus, technological characteristics of digital platforms make them relatively open and subject to a fluidity of control (Yoo et al. 2010). This is in contrast to platforms that build on a physical device upon which de facto standards can set a situation of coercive lock-ins or predatory actions by actors due to the leverage they hold on control points in the network (Pagani 2013, Skog et al. 2018). Scaling digital platforms thus turn to be highly uncertain and dependent on decisions across multiple actors beyond the control of a single actor. To conceptualize how platform owners can scale a platform’s user base and services, we draw on the concept of value-driven lock-ins.

**Value-Driven Lock-ins**

A firm’s resources (both tangible and intangible e.g. idiosyncratic knowledge) play a key part in sustaining its competitive advantage (Wernerfelt 1984). Three distinct actors are central to the scaling of platforms, a
heterogeneous group of apps developers, producers and a platform owner that together constitute a network of actors. The value proposition of the platform to each group of users differs across the ecosystem. The platform's role is to generate capabilities that align its resources with these distinct group of actors i.e. aligning its resources to provide a relevant value offering that solves an essential "system" problem (Gawer 2008). Thus, we conceptualize value-driven lock-ins in scaling platforms as value-driven moves platform owners leverage to grow a constantly evolving set of resources sustaining value among a network of actors. These value-driven moves orchestrated through resource configurations aim to generate value by enhancing (1) a shared worldview to reduce cognitive distance between platform owners and distributed actors, (2) enabling both structural flexibility and integrity, and (3) provision of an architecture for participation (Lusch and Nambissan 2015, p.162).

A shared worldview, or a common frame of shared understanding across the ecosystem, refers to resource configurations that platform providers develop in aligning itself with the social world of actors (Lusch and Nambissan 2015). Distributed actors (e.g. app developers and producers) are distinct in terms of their interests, practices and vary in their interpretations, usage of resources and identity (Tuomi 2002). Because platform owners exert limited influence on the preferences of these network of actors, they tend to be cognitively distant from the platform owner in terms of variation in knowledge and skills (Lusch and Nambissan 2015). Platform owners due to this limited influence on this network of actors can turn to purposely engage users through relationships that are aligned with the social practices of actors. Value-driven moves will constitute resource configurations that platform owners develop to align resources towards understanding the practices of these communities. Networks for collaborative learning, that help connect users and resources (Hagel III and Brown 2011), engaging users in activities such as in solving a problem through apps competitions, exhibitions and innovation contests provides vital feedback (Terwiesch and Xu 2008). Potential platform owners can leverage such contests in testing a platform’s value proposition and receive feedback on plausible services to the view of users.

Structural flexibility and integrity refer to "the ease with which different configurations of actors can participate in the ecosystem to adapt to new environmental stimuli... to create new service innovation opportunities" (Nambissan and Lusch 2015, p. 163). Because actors constituting the network will differ in terms of their skills and needs as the ecosystem evolves, as a consequence, considerable variation can exist in terms of the quality and diversity of services created. Such diversity, while healthy for the ecosystem as it creates variety, can also result in chaos (Tiwana 2013). Prior research indicates that exercising control and autonomy across developers engaged in the development of services is often contested as resources are distributed across distributed and heterogeneous actors (Eaton et al. 2015; Ghazawneh and Henfridsson 2013). Because tension can often arise from such collaboration due to irreconcilable demands or contradictions (Wareham 2014) between the platform owner and app developers, value creation is often fostered by agreements with developers seeking to align divergent goals in the ecosystems. To interoperate value creation opportunities with the wider ecosystem, platform owners will seek to ensure integration through rules that guide how app developers can integrate their tasks incurring the least systems integration and app innovation cost. App innovation costs include efforts associated with the design and implementation of an app, while system integration costs constitute efforts developers may incur in ensuring an app is interoperable with the platform due to changes made on an app (Tiwana 2013). Platform owner will leverage boundary resources i.e. "software tools and regulations that serve as the interface for the arm’s length relationship between the platform owner and the application developer" (Ghazawneh and Henfridsson 2013, p. 176). For example, resources such as APIs, application toolkits and documentation through different configurations provide the platform owner a basis upon which to govern the ecosystem, ensuring appropriate behaviors, facilitating interaction, control and coordinate different actors (Tiwana 2013).

An architecture for participation refers to the rules and mechanisms through which platform owner leverage to coordinate and maintain system-wide integration of value exchanges, output and collaboration among the network of actors (Lusch and Nambissan 2015). Since a platform’s value is dependent on resource recombination by other actors in the ecosystem, the tendency for the platform owner will be to reconfigure resources in ways that enhance the ability and motivation for the users to continuously rely on the platform to create value. The ability to generate value creation opportunities on the platform is dependent on the platform’s architecture, while the motivation to do so is dependent on platform governance i.e. incentives, decision rights and control (Tiwana 2013). Systems integration efforts to sustain value creation involves "coordination of development activities among app developers and the platform

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owner (Tiwana 2013, p. 82). Thus, to enhance value creation opportunities on the platform and attract users, platform owners will seek to provide both incentives and rules for ensuring diversity of different actors and ensure output is rewarded to encourage participation on the platform. In summary drawing on Lusch and Nambissan (2015), we operationalize value-driven lock-ins in scaling digital platform ecosystems as constituting three main resource configurations that seek to address (1) a shared worldview, or a common frame of shared understanding across the ecosystem, (2) Structural flexibility and integrity and (3) an architecture for participation. Drawing on these three dimensions, we explore their operationalization within a case of a digital platform ecosystem.

**Research Design**

To explore the role of value-driven lock-in in scaling platform ecosystem, we build on a case of an open API (Application Programming Interface) platform Trafiklab, that provides APIs for users to develop services across multiple context and devices. Trafiklab does not hold proprietary ownership of the services or share in the revenue streams generated from these applications and has limited influence over final outcome of the services. Trafiklab was launched in 2011 as a collaboration of public transport operators and a research institution intended to engage the public in developing digital services for public transport. An essential role of Trafiklab was thus to ensure it scaled in terms of attracting users and increase the diversity of services a focus of our study. Also, Trafiklab constituted developers and data providers with distinct interests thus interesting for our study. Trafiklab has over 3000 users and about 2200 service. We use this case in exploring how Trafiklab sought to appeal to different groups, exploring different resource configurations.

**Data Collection and Analysis**

Data used for this study consists of in-depth interviews and secondary sources. In total, 20 interviews were conducted of which (15) interviews were conducted with Trafiklab, (1) interview with a key stakeholder who participated in the development of Trafiklab's APIs, and, (4) interviews with organizations providing data to Trafiklab. Documents from Trafiklab and scrapped data from publicly available weblogs such as, "Trafiklab/News" and Trafiklab.se were also used. Interviews were conducted between Mar 2015 - Sept 2016 at Trafiklab's office, Skype and on phone, lasting between 45 and 90 minutes.

Data analysis was both informed by a prior theorization of value-driven lock-ins and equally grounded in the data. To get an understanding of value driven lock-ins moves in the scaling of Trafiklab, interviews were all transcribed and coded using atlas.ti a software tool for data analysis. Scrapped data with timestamps provided a timeline uncovering various resources and activities Trafiklab engaged in. The scrapped data together with interviews were openly coded (Charmaz 2006; Corbin and Strauss 1990) whereby a code was attached on segments of the data that provided an initial sense of the data. Doing so we identify broad categories of codes on different instances/activities and resources. Through focused coding (Charmaz 2006) later rounds of interviews, sought to explore motivations i.e. why such activities and actions were carried out. For example, frequent occurring actions e.g. meeting with developers and data providers, changing APIs, updating API requests, varying levels of APIs requests, participation in different travel hacks etc informed subsequent interviews. Schultz and Avital, (2011) refers to this method of qualitative interviewing to generate data as laddering interviews which aims to gain participants' account on certain pre-determined or identified constructs. Through comparison, categories were narrowed down, merging similar categories together. For example, *rules of using APIs, APIs libraries, updates on APIs* etc, were merged together into a broader category *Maintaining interoperability across services*. The motivations for the different activities served as variations of different ways of how Trafiklab leveraged its resources to enable value-driven lock-ins. Thirdly, we explored patterns between the categories grouping them under three main constructs informed both by the literature and grounded in the data. From the timeline of activities, we subsequently sort to identify a sequence in which these activities were carried out.

**Results**

Our results are structured according to the three dimensions of value-driven lock-ins, i.e., integrity, bridging cognitive distance across actors, structural flexibility and integrity, and enabling an architecture for participation. Based on these overarching concepts, we describe how distinct types of value-driven lock-in effects influenced the scaling of Trafiklab.
**Bridging cognitive distance across actors**

*Aligning with Developers Culture:* The emergence of smartphones brought a clash between two fundamental logics within the public transport industry. On the one hand was a public transport industry logic dominated by clear and established routines and bureaucratic environment driven by an in-house approach to the development of service. On the other hand, were increasingly technology-savvy citizens constituting developers who wanted to create services and leverage the possibilities for distribution enabled by smartphones. However, this was not a straightforward process as the bureaucratic view of the industry and approach to service development could not be easily translated or replicated to the context of distributed actors engaged in developing services. Thus, Trafiklab had to cultivate an environment that could adjust to the frames of these actors who often worked very independently. Trafiklab sought to create a conducive environment through the development of attractive APIs and being agile in responding to the developers to foster the development of services.

*we focused more on aligning with developers’ culture, through developing APIs attractive, for third-parties, and creating an environment that is more agile with less bureaucracy [project leader]*

*Facilitating Resources Interpretation through meet-ups:* Furthermore, in order to build a common understanding with developers and API providers enrolled on the platform, Trafiklab organized social gatherings where developers and providers could meet. These interactions were intended to foster sharing of ideas among users attracted to using the APIs on Trafiklab’s platform. Trafiklab Meet-ups, a gathering of third-party developers and data providers, were a key means instituted to achieve this endeavor. These meet-ups had the added advantage that developers had face-to-face interactions with the data providers and experts, who discussed the importance of creating services that address societal needs aligned with the interest of most developers who engaged in Trafiklab as a hobby. Developers also had the chance to meet different groups of developers and share ideas or problems encountered in developing services.

*we have four meet-ups a year where we invite third parties. Most APIs owners attend these meet-ups and meet with third parties directly. We listen to presentations and to know whether they have questions on how we can develop the APIs [Trafiklab Manager]*

Building Relationships to facilitate a common understanding. Trafiklab also sought to complement the meet-ups with regular face-to-face meetings with different data providers. This was an effort to build good relations and trust given that the public transport operators were often unaware of the possible ways and what developers thought of their data could be used. Building such relationships was important considering that Trafiklab had to gain the support of data providers, to guarantee that developers had a continuous flow of APIs to develop services. Interaction with data providers was also used as an opportunity to share insights and views on how changes on APIs could be designed so as not to affect the work of the third party. For example, as the head of the IT support indicated:

*I have regular meetings with SL where we try to build good relationships... to keep our cooperation moving forward... and we discuss questions from developers, and we try to solve them [IT Support]*

**Addressing structural flexibility and structural integrity**

*Maintaining interoperability across services:* Another major activity that Trafiklab engaged in to ensure the emergence of service in its ecosystem was the development of data formats interoperable with other technologies adopted in the wider developers’ community. A case in point was the release of new APIs with GTFS (General Transit Feed Specification) format. GTFS is the data format used by Google transit, adopted by a large number of developers developing application within the public transport. Trafiklab relied both on its technical resources to increase the scale of the services and functionalities that the services could offer. Changes in data format were accompanied by development of new API Libraries, APIs upgrades with enhanced features and functionalities thereby broaden the scale and scope of possible services developed by third party applications. To guide developers on the possible directions of future services, Trafiklab ensures APIs updates were communicated to developers. This was done on the developer’s forum. These changes for example, bus-stops changes, and APIs updates on data providers e.g. SL (one of the main actors in its ecosystem) helped in providing developers a sense of the future directions of Trafiklab. This also helped as measure of maintaining the expectations of developers and ensuring of stability in the services
developed. Overall these measures aimed at increasing the scale and interoperability of services across different data formats used by developers, to increase enrolment of more users to the platform.

*The life history of an API is associated with changes, new parameters and functions are added. A lot of things do change, we keep them updated on future changes to help them develop services [Head of IT]*

Beyond the service agreements that required developers ensure standards in services developed, another measure of control that Trafiklab institute was the use of different level of control and access. This measure relied on the output of the specific projects of the developers as APIs Keys were matched with the projects of the developers. Through this matching measure access to developers to APIs based on the specific needs of developers and the usage of the applications developed.

...*The API key is matched to the user and the project. It checks out how many requests you do per month or minute, and shows which users are making the requests [Head of IT support]*

*Communicating future changes*: Besides meet-ups and regular meetings with data providers, Trafiklab used newsletters specifically targeted at developers who were to be affected by future changes in APIs. This helped in keeping developers aware on what was expected of them or how such changes in APIs could be reflected in the application developed to avoid any disruption on the services.

*In the newsletters, we point out to specific developers that changes on certain APIs would affect their work. We explain why we change the APIs...and find out what they need to develop better services [IT support staff]*

*Rules for coordination*: Given the heterogeneity of different stakeholders and interests of developers involved in Trafiklab ecosystem, Trafiklab sought to ensure that output of the services were of better quality. To ensure control and quality of services, developers had to sign agreements before they could start working on the APIs. This was mainly done to ensure that services developed were of acceptable standards. In this way Trafiklab could control and ensure applications developed were inappropriate according to the standards in the agreements.

*We have key management system, third parties that want to work with our data need to sign up for different APIs keys ... and agree to, how they will use the data [Trafiklab Manager]*

**Providing an architecture for participation**

*Rules and Incentives for participation*: To increase users’ participation in the ecosystem, Trafiklab, developed a progressive scale on the access of different developers, which could be extended based on the usage of the application developed. This measure of control aimed at ensuring quality of services developed as developers could be restricted to lower levels of request if the quality of services developed were not of high standard. It could also be seen as way to encouraging developers to provide better services if they want to move to a higher level of API request amongst their peers on their progress.

*The bronze level is 10 thousand requests/month. The silver is 100,000 requests/month. The gold level ranges from 10 to 12 million requests/month. It's a big step to move from Silver to gold. That is also a way of ensuring that service which are created... receive greater access rather than just create traffic in the system from services which are not used [IT support].*

*Leveraging competence across the ecosystem*: Another measure that Trafiklab instituted to facilitate interaction with developers and encourage service development was the initiation of a first *line of support*. Because different actors in the network actors had different competencies, Trafiklab sought to leverage the unique competencies to resolve problems that can be encountered when developing services. By doing so Trafiklab sought to increase and provide an environment favorable to the development of services and serving time for developers through the fast response time.

*we forward other questions about SL's data structure to competent persons in the organizations to look into it more carefully and provide relevant feedback [Manager Trafiklab]*

*Diversifying Ecosystem Participation*: Building on relationships established across the network of actors, Trafiklab also sought to attract developers and services to its ecosystem through organizing innovation activities within developers' communities. Such events took the forms of travel hacks, innovation contest, where developers were expected to create services addressing specific innovation problems within a limited
period of time. For example, My-Idea Contest launched in 2011 involved the participation of developers in a contest during which participators came-up with an innovative idea that encouraged the sustainably use of the public transport. Similarly, an App Contest to create an app for disabled travelers launched by the (Swedish Post and Telecom Authority (P.T.S) in partnership with Trafiklab whereby contestans had to develop Apps addressing the needs of the deaf and blind to facilitate use of the public transport. Trafiklab was relatively unknown in the communities and needed a large user base to convince data providers to provide more data on the platform. These activities aimed to showcase plausible services based on public transport data so as to attract developers and encourage participation of data providers.

In travel hacks we invite developers. They are expected to develop apps within a short period of time. This has been a way for us to attract new third parties, explore new kinds of services and how we could design APIs. We also use this to keep stakeholders informed of our work [Trafiklab Manager]

Discussion

Our analysis of Trafiklab provides insights into resource configurations that platform owners leverage to increase interaction among users and enable the development of diverse modules on a platform. Value-driven lock-ins involve resource configurations that seek to appeal rather than coercively engage users to contributing to service development. These resources configurations are discussed subsequently.

**Bridging cognitive distance across actors to enable platform scaling:** Our research at Trafiklab indicates that platform owners can seek to bridge cognitive distance across actors in the ecosystem through interactive learning organized in informal settings. In our case, resources to foster interactions across actors included meet-ups, the design of API prototypes, development of an agile environment for the development of services, forging relationships across actors to build trust and social norms, and design of user-friendly interfaces that encourage users to rely on Trafiklab to develop services. Together these resources broadly aim to enable a common understanding across users. For example, meet-ups involve a face-to-face interaction between data providers and third-party developers. Such interactions aim to enable exchange of ideas among actors and have been shown to be of importance when resources e.g. knowledge is unequally distributed across actors (Hayek 1945). While such meet-ups were intended to facilitate knowledge sharing, the informal nature of such meet-ups could be seen as an effort to align with the social norms of developers. Our analysis indicates platform owners can enhance such interactive learning by leveraging relationships across the ecosystem in solving problems encountered by other users. This is in line with previous studies that recognize the distribution of knowledge across users and the need for problem-solving to be distributed (Lakhani and Panetta 2007). Another resource that platform owners use in bridging cognitive distance across actors is the use of prototypes and API libraries designed to guide users with different knowledge-base. By providing users multiple options on how to approach the development of services, such libraries serve as boundary resource (Ghazawneh and Henfriddson 2013) that enables platform owners the possibilities to extend the user base of the platform irrespective of the cognitive distances with distributed actors. The focus of Trafiklab on resources that could enable a common understanding could be explained by the fact that Trafiklab had little or no control over these distributed actors. As such Trafiklab had to focus more on ways that could be perceived as favorable and trustworthy to developers to ensure they created services. Thus, a key aspect in value-driven lock-ins requires that platform owners can sense, build trust and recognize differences across users in the ecosystem and leverage those differences to enhance diversity in services that provide value to different actors.

**Forging structural flexibility to enable platform Scaling:** Our analysis indicates that maintaining structural flexibility and integrity involves a combination of different resources. For example, agreements with third parties were used as a way of ensuring appropriate behavior in the ecosystem. For example, before signing-in to develop services, developers were expected to fill a form indicating that use of the APIs will be in line the specifications of the keys. Besides this technical aspect, building close interactions with developers and API providers also meant a need to ensure appropriate behavior to stay within the community. Other types of resources provided to this end involved the use of newsletters reflecting changes, API upgrades and use of API key management systems. For example, an API key matching system leverages assigned keys designated to various projects and developers to ensure that services are in line with the specification of the keys. By matching users and projects through API management, platform owners ensure services developed by different developers are easily integrated. This has the added advantage in that communication with users can be targeted to address specific concerns based on the usage of the assigned
API keys. Also, the use of newsletters to inform users of possible future changes can be seen as a way of providing a level of certainty or maintaining stability in the ecosystem.

**Enabling an architecture for participation to enable platform scaling:** The Trafiklab case indicates that enabling an architecture for participation in platform ecosystem can take different forms. Platform providers can leverage different level of access provided to platform resources as a way of incentivizing distributed actors by progressively increasing availability of resources. Another available measure to increase the participation of actors is the use of innovation contest and travel hacks. These travel hacks as used in our case were intended to expand the platform user base by attracting diverse users and to explore possibilities of new services that can be developed. Platform owners also use incentives such as prize awards to encourage the development of services in such travel hacks. These incentives, were geared towards addressing societal problems rather than economic returns that could be generated from these services. Appealing to broader societal concerns can be seen as a way of motivating developers by leveraging intrinsic motivation. Platform owners might thus consider not only economic motivation, such as subsidies often suggested by the literature on two-sided markets (Rochet and Tirole 2003; Eisenmann et al. 2006), but also how to design for intrinsic motivation. These actors can play the role of providing resources, enable discovery on the platform, and provide legitimacy for the platform when it is relatively new. Experimentation on a platform by key users can play an essential role in demonstrating the value a platform can provide. Our research at Trafiklab indicates that platform owners leverage different options when considering how to enable participation on a platform.

**Conclusion and Suggestions for Future Research**

Although research suggests that value-driven lock-ins can be used as a means of scaling platforms, little research has theorized about its operationalization. Operationalizing the role of value-driven lock-ins in platform ecosystems can provide insights towards understanding how digital platforms can be designed to encourage contribution from external users. This study makes the following contributions. First, it provides empirical evidence on how value-driven lock-ins are operationalized by identifying types of resource configurations platform owners leverage. Secondly, our operationalization of value-driven lock-ins highlight ways in which digital platform with distributed ownership of resources can be configured to create value for distributed actors. We also contribute to recent research on the need to identify resources that can help in fostering a shared viewed in a network of actors in a service ecosystem (Lusch and Nambissan 2015). Future work could examine how value-driven lock-ins could vary across platforms, focusing both on the resources leveraged and how lock-in as a process plays out among competing platforms. Exploring the challenges and the role of power dynamics between platform owners and actors in the ecosystems in explaining different value-driven configurations could be an interesting area for research. Institutional logics Thornton and Ocasio (1999) could be useful in exploring these dynamics.

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