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Development and competition of digital service platforms: A system dynamics approach

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ABSTRACT

Digital service platforms are becoming widespread in all areas of society. One risk scenario in platform development is related to the fragmentation of development efforts and the failure to achieve a critical mass of platform users, while a second risk scenario is related to a winner-take-all situation in which one platform firm achieves a monopoly position in the market. We develop a system dynamics model of platform development that includes two competing platforms, and use the model to simulate various development paths by varying different factors that affect how resources accumulate to the platforms. Our simulation results show that delays in users' decision making can increase the likelihood of achieving critical mass. In addition, open interfaces and data transferability between platforms can accelerate platform adoption and decrease the likelihood of a winner-take-all situation. The simulation results also reveal more nuanced development paths than simple S-shaped growth because of delays in platform development and different cross-side network effects to end users and service providers.

1. Introduction

The application of information and communications technology is reshaping all areas of our society. It can be used to improve productivity and to develop new kinds of services by integrating solutions from different industries, such as energy, mobility, and built environment. For example, the application of information and communications technology in a city environment has been termed 'smart city', and the concept has been approached from a variety of different viewpoints, ranging from technological applications to city infrastructure (Harrison et al., 2010) to new governance and organizational structures enabled by the technology (European Parliament, 2014). It also presents potential opportunities to introduce digital platforms that enable the flow of information across isolated city and sector specific information systems, which would facilitate an efficient use of resources.

Digital platforms can mediate the flow of information and thus enable the interconnection of products and services, as well as data flows between different actors (cities, service providers, and end users) on multiple sides of a platform. Digital platforms have mostly attracted attention in the context of consumer applications, such as Uber and Airbnb, and academic studies have focused mostly on the context of mobile phones, such as Google's Android platform (Pon et al., 2014) and Apple's iPhone platform (Garcia-Swartz and Garcia-Vicente, 2015). In the future, however, digital platforms can also become important in many other sectors, such as the smart city context.

When a community of actors is developing platform-based services in a smart city context, it is important that a critical mass of actors is reached in order to achieve self-sustaining growth. An important question also relates to the degree of openness of these platforms. The evolution of platforms often tends to follow a so-called winner-take-all dynamic where one platform gains dominance and a gatekeeper role. These kinds of situations can be especially problematic in a smart city context if they relate to publicly critical services or infrastructure. This means that interoperability through open and common interfaces and easy exchange of data across platforms can be important factors in enabling competition across platforms and their continuous development.

There are many smart city related sectors where digital platforms could emerge. One example comes from the field of transport. Mobility as a Service can be considered as a new transport paradigm which aims to integrate different modes of transport, such as buses, trains, and shared cars into a service package. As a result, users would not need to have separate accounts and tools for each mode of transportation when planning and paying for their trips. Automatic data gathering could also enable better demand responsive public transportation. The new service concepts could be implemented with the help of a multi-sided platform, which would link different end user groups, transport operators, and software developers. Recently, a European alliance[1] has been set up to promote the collaboration of various development efforts related to Mobility as a Service in different countries, and some start-up companies as well as more established firms have started to develop such services.

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[1] www.maas-alliance.eu (website accessed 4th of November 2016).

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In this article, we develop a simulation model and use the model to analyse the development and competition of platforms. We use a Mobility as a Service example to illustrate the results. The rest of the paper is organized as follows: Section 2 presents a review of relevant literature on platforms; in Section 3, we present the methodology used, namely system dynamics modelling; Section 4 describes our simulation model; and Section 5 describes model validation issues; the results of the simulations are presented in Section 6; after which the impacts of policies are analysed in Section 7; finally, our conclusions are presented in Section 8.

2. Literature review

2.1. Achieving critical mass

Gaining a critical mass of end users, developers, and service providers and achieving self-sustaining growth and scalability is a key issue for the success of platforms. Initially, platform development may be financed, promoted, or otherwise subsidised using external funding, but over the long term the success of a platform depends on a viable business model and the ability to attract customers. In the initial phases of platform development, a common problem is a so-called 'chicken-and-egg' situation in which too few developers and service providers of a platform inhibit the growth of the end user customer base, and vice versa (e.g. Casey and Töyli, 2012a). In order to achieve a critical mass, development resources have to be allocated in the right way. If there are many competing and non-interoperable platforms there is the risk that no platform achieves a critical mass. In a smart city context, for example, individual cities may develop fragmented platforms that target only a small set of potential customers, and the number of end users remains low or decreases when publicly funded development efforts end.

Achieving a critical mass and being able to scale up a platform depends crucially on network effects (Katz and Shapiro, 1986) created by a platform. Direct network effects refer to situations in which the value for an actor group depends on the size of the same actor group. For example, the value of a social media platform for an end user increases with an increase in the total number of end users. By contrast, indirect (or cross-side) network effects refer to instances in which the value for an actor group depends on the size of another actor group. For example, the value of a mobile phone operating system platform for end users depends on the number of application developers (and the applications developed by them), and vice versa (Garcia-Swartz and Garcia-Vicente, 2015). Furthermore, in modern internet-based platforms, the role of data is crucial, and network effects due to data accumulation can be substantial.

Understanding network effects is crucial for understanding two-sided (and multi-sided) markets, in which a platform mediates transactions between demand and supply side actors. In two-sided markets, a platform owner can subsidise one side of the market in order to increase platform adoption and charge another side of the market instead (Parker and Van Alstyne, 2005). In other words, the price structure (Rochet and Tirole, 2006) matters in addition to the level of pricing. In multi-sided platforms opening boundary resources (Ghazawneh and Henfridsson, 2013), such as application programming interfaces, can enhance the magnitude of network effects since third parties can integrate their applications to the platform.

The dynamics of platforms are also influenced by other reinforcing feedback mechanisms related to the adoption of technologies and the growth of firms. These include the accumulation of knowledge and informational increasing returns, which have been studied with computational modelling (Safarzyńska and van den Bergh, 2010) and qualitative case studies (Klitkou et al., 2015). Furthermore, changing societal norms and the practices of consumers, firms, and the public sector can have an important role. Because of old ways of operating, different actor groups might not initially perceive the value of a platform and potential reinforcing feedback mechanisms can thus remain untapped.

2.2. Platform competition and winner-take-all markets

In order for firms to have an incentive to take risks and invest in platform development, the platform must be a source of competitive advantage to them. This requires that they must be able to lock in customers to some extent, and thus aiming for excessive openness in platform development may not be the best option. From a platform owner perspective, openness reduces switching costs for users and intensifies competition (Eisenmann et al., 2009).

However, because of the multiple reinforcing feedbacks in platform based competition, there is a tendency for a winner-take-all scenario to occur in which the market leader is able to harness increasing returns mechanisms and lock out competitors. This can have a negative overall effect on the innovativeness and development of an industry (Gawer and Cusumano, 2014). Whether or not an industry should be allowed to develop to a winner-take-all situation is an important public policy question. On the one hand, if the clock speed (Fine, 2000) of an industry is fast, it can be argued that monopolies do not last for long because new entrants with better technologies or service concepts can effectively challenge the market leader. On the other hand, platform monopolies can be especially problematic in situations that involve publicly critical infrastructure and services, e.g. related to energy production or transport (parts of the smart city context) with a slow clock speed and long development cycles.

A winner-take-all situation is more likely when network effects are positive and strong, multi-homing costs are high, and there are no differentiation opportunities in the market (Eisenmann et al., 2006). Rysman (2009) also mentions the possibility for the providers of complimentary goods to differentiate their offerings as a factor that may lead to a winner-take-all situation. In the context of digital platforms, the overall network effects can be strong because of data accumulation to a platform. In addition to this, multi-homing costs can be high due to non-standard development toolkits or application programming interfaces, which result in extensive integration efforts for developers who want to use different platforms. For example, in the context of Mobility as a Service, there could be separate implementations of public transport payment and journey planner applications for each city, and extra costs would be generated to access data across the platforms.

There are also factors that can even out competition and make a winner-take-all situation less likely. One mechanism is the competitive crowding phenomenon in which a large number of developers on a platform decrease innovation incentives because of excess competition (Boudreau, 2011). Also, competition can increase if the market leader invests less in platform development than competitors (Markovich and Moenius, 2009). Finally, a firm can use a platform envelopment strategy in which it leverages assets in one industry in order to gain a competitive advantage in a neighbouring industry (Eisenmann et al., 2011).

2.3. Competition and collaboration in business ecosystems

A group of companies pursuing a business model through a mediating platform can be described as a layered and interconnected value system (Stabell and Fjeldstad, 1998) and involves collaboration and competition between different actors within an ecosystem. However, in order for an ecosystem to develop to this desired state, the risks of the chicken-and-egg scenario (failure to achieve critical mass) and winner-take-all scenario have to be avoided with an appropriate value orchestration strategy and corresponding policies.