Digital Business 2 (2022) 100044

Contents lists available at ScienceDirect

Digital Business

journal homepage: www.elsevier.com/locate/digbus

Developing network effects for digital platforms in two-sided markets – The NfX construction guide

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ARTICLE INFO

Keywords:
Network effects
Virtuous cycles of network effects
Digital platforms
Platform business model
Construction kit

ABSTRACT

Context: What do Uber Ride, Airbnb Lodging, and eBay Marketplace have in common? All three platform business models generate extensive network effects (NfX) between providers and consumers. Network effects are the magic force that turns a single taxi service agency into a provider for an entire mobility market.
Objective: The goal of this paper is to present an approach, namely the *NfX Construction Guide*, that enables the design of virtuous circles of network effects in two-sided markets for platform business models.
Method: The research design we used to develop the NfX Construction Guide is inspired by action research and follows a technical action research method, by exploring the guide's applicability in a real-world project of a digital platform for smart rural areas.
Contribution: The contribution of this paper is an approach, validated with ecosystem experts, that enables practitioners to design virtuous cycles of network effects for platform business models. Our results are summarized in reflective learnings about the applicability of the proposed approach.

1. Introduction

Platform business models, like those of Uber or Airbnb, open up new opportunities for creating and capturing value with digital platforms (Zhao, von Delft, Morgan-Thomas, & Buck, 2020). Scholars from diverse fields become interested in these types of organization (Gawer, 2014; McIntyre & Srinivasan, 2017; Täuscher & Laudien, 2018). The networked information economy enables a new paradigm of many-to-many relationships among market participants (Benkler, 2017). The interest in platform business models is growing because, unlike traditional pipeline business models, digital platforms create value not through a linear series of activities from input to output, known as the *value chain*, but through a *value network*, by connecting different market sides via a digital platform to enable an intermediation service (Täuscher & Laudien, 2018; Wirtz, So, Mody, Liu, & Chun, 2019). In order to establish a platform business successfully, one challenge frequently mentioned in the literature needs to be addressed: *How can positive network effects be designed for platform business models?* (Jung, Wortmann, Bronner, & Gassmann, 2021; Parker, Van Alstyne, & Choudary, 2016). Research publications increasingly point to the importance of network effects (NfX), so these should not be overlooked (Watanabe, Naveed, Neittaanmäki, & Fox, 2017), as platform business can grow exponentially through the power of network effects (Cusumano, 2015: p. 32; Tussyadiah & Pesonen, 2016; Watanabe et al., 2017). In this context, when designing network effects for a digital platform as part of the *Smarte. Land.Regionen* (SLR) project,[1] we encountered three challenges:

(1) Chicken-and-egg problem. The question here is: What has to be there first – providers or consumers? As a rule, providers first want to know consumers on the platform before they appear as providers. However, consumers first want to see providers on the platform before they try out a new format.
(2) Critical mass problem. A provider of a digital platform needs to think about how to address both sides of the market. This leads to a second problem: Digital platforms for two-sided markets need to reach a critical mass (i.e., growth without any external investment) as quickly as possible in order to be self-sustaining.
(3) Lack of tools for designing network effects. Another challenge is the use of a suitable tool and modeling techniques to develop

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[1] https://www.landkreise.digital/: In this project, a digital platform encompassing digital services and applications is being established to help rural areas position themselves well for the digital future.

https://doi.org/10.1016/j.digbus.2022.100044
Received 24 June 2022; Received in revised form 20 September 2022; Accepted 5 October 2022
Available online 7 October 2022
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appropriate concepts and models to explain the platform's creation strategy of network effects.

Insightful observations of the mentioned challenges can be found in the work of Navidi, Nagel, and Winter (2019), Parker et al. (2016), and Parker and Van Alstyne (2005).

Although platform business models are highly influenced by network effects, which appear when the value of a product or service increases as more users utilize the platform (Parente, Geleilate, & Rong, 2018), there is a lack of approaches that can be used to design network effects for platform business models. In this paper, we propose a first version of an approach, called the NfX Construction Guide, that can be used to design virtuous cycles of network effects for platform business models in order to address the challenges mentioned above. As this approach is a designed artifact for digital platforms, we follow the Design Science methodology of Wieringa (2014). The research design of this paper is on the *Technical Action Research* (TAR) cycle and focuses on the construction and validation of our proposed approach for the design of virtuous cycles of network effects. In addition to the methodological description of the NfX Construction Guide, we present our approach using the Uber Ride platform as a well-known example and validated it for a use case. The use case relates to a research project, the SLR project, in which the authors were involved. The contribution of this paper provides reflective learnings that can be used by practitioners and scholars seeking to design virtuous cycles of network effects for platform business models. These lessons are based on our experience in validating the approach in order to understand its limitations and improve it.

2. Theoretical context

Our paper builds on four research streams: platform business models, network effects, two-sided markets, and platform design. Platform business models and network effects can be studied as existing artifacts; e.g., with respect to their competition behavior (Katz & Shapiro, 1994), strategic pricing and efficiency (Hagiu, 2004; Parker & Van Alstyne, 2005), disruption (Watanabe, Naveed, & Neittaanmäki, 2016), or future perspective (Wirtz et al., 2019) to mention but a few. We take a design perspective on platform business models and network effects, similar to the platform design approach of Tura, Kutvonen, & Ritala, 2017.

2.1. Digital platforms and platform business models

Following the definition of Koch, Krohmer, Naab, Rost, and Trapp (2022), we see a digital platform as a software system to enable a digital ecosystem service that facilitates the exchange of assets (e.g. products and services) between their providers and consumers. A digital platform can be seen as the technical core of a socio-technical system, a so-called *digital ecosystem*. When a business model bundles several actors via a digital platform, we consider this kind of a business model as a platform business model – examples include the business models of Airbnb Lodging, eBay Marketplace, Spotify Music or Uber Ride (Bartels & Gordijn, 2022; Täuscher & Laudien, 2018).

We advocate the logic that e.g. Airbnb Lodging (*asset broker*) brokers (*digital ecosystem service*) accommodations (*assets*) provided by hosts (*asset providers*) for travelers (*asset consumers*) on its digital platform. Consequently, the composition between (1) asset broker, (2) asset providers, and (3) asset consumers is highly important to design a digital platform as an enabler of a digital ecosystem service with positive network effects between providers and consumers (Koch et al., 2022).

2.2. Network effects in two-sided markets

Software services companies like Google are based on large network effects (Aigrain, Chan, Guédon, Willinsky, & Benkler, 2008). In general, network effects are effects that have an impact on the value of a good to a participant that arises from the overall number of participants. Network effects are external effects, meaning that the behavior of one person is influenced by the behavior of another person. Due to the self-reinforcing effect of network effects, goods with larger networks are more attractive to their consumers / participants. The relationship between a network's size and its value is also known as Metcalfe's Law and has raised a debate about how to determine a network's value (Hendler & Golbeck, 2008). However, there is consensus that the mass of participants becomes a key factor for the (economic) success of a network (Katz & Shapiro, 1994; Sorri, Seppänen, Still, & Valkokari, 2019; Wiedemer, 2007).

Network effects and their creation are particularly important for digital platforms (Trischler, Meier, & Trabucchi, 2021). There are two sides that characterize a digital platform from an economic perspective: asset providers and asset consumers, which interact with each other via the digital platform. Accordingly, digital platforms form a crucial component of so-called two-sided markets. The goal of such two-sided markets is to balance the network effects of both sides so that positive network effects are generated continuously (Hagemeister, 2009).

In the case of positive direct network effects, the individual utility of a good increases when a large number of users consume this good (chat tools, software, programs, apps, etc.). Positive indirect network effects occur when the value of the good for one side of the market increases when a new user from the other side joins the network. For example, if more asset consumers use a digital platform, the demand for software products increases and the platform becomes attractive to more developers (asset providers), who in turn increase the supply of software products that attract more asset consumers (Evans & Schmalensee, 2008). Ideally, the participation of one side of the market promotes the participation of the other side of the market in the platform, so that the creation of network effects on the respective market side is constantly driven forward without the intervention of the asset broker. This means that asset providers and asset consumers create direct and indirect network effects out of their own motivation (Clements, 2004; Li, Liu, & Bandyopadhyay, 2010). Thus, the strategy for generating network effects should be designed in such a way that these network effects will occur by themselves over time. There is no one-size-fits-all solution for developing sustainable network effects, as each network effect business is characterized by its own business model, audience, environment, and so on. Consequently, each business has to find out on its own how to create and grow value for its users (Parker et al., 2016).

2.3. Platform design and network effects

A kit that has been developed for use in the design of platform innovations is the *Platform Innovation Kit 5.0* of Walter (2022), which consists of 21 tools and templates intended to help (1) discover and launch a platform and (2) scale and grow a platform. One of these tools is the *Network Effects Stimulation* canvas. Its purpose is to identify network effects on a platform that rely on the relationships between the different stakeholders of the platform. Thus, it focuses on the two sides of the platform (providers and consumers), the value (proposition) that is exchanged between these two sides, and the benefit gained for both market sides as a result of the value exchange. Additionally, the template can be used to design direct network effects within one market side and indirect network effects between both market sides, and offers the modelers space to define supporting activities of the asset broker aimed at pushing and promoting the considered network effects and the platform's value proposition.

Tura et al., 2017 developed a framework for platform design, that involves platform architecture, value creation logic, governance and platform competition. A component of the value creation logic is also the design of value creating network effects. However, this involves design decisions about which actors are necessary to enable value creating network effects, and is thus a design problem. Here, the authors take a design perspective on platforms and develop a framework for platform design. They provide a case study of a mobility-as-a-service platform to

prove their approach.

A classification of network effect characteristics and strategies is provided by Currier (2021), who points out many challenges that platform business models and their network effects have to deal with, which are also highlighted by other authors – e.g., the chicken-and-egg problem (Navidi et al., 2019) or the platform challenge of reaching a critical mass of users (Evans & Schmalensee, 2010). Similarly, Parker et al. (2016) show eight detailed strategies and further observations on how platform business models can solve the chicken-egg problem. The authors do not advocate a one-size-fits-all solution that can be used generically, but point to potential solutions to this problem. One example is the so-called *piggyback strategy*: attract an existing user base from a different platform to recruit them (e.g. PayPal initially focused on eBay's user base and offered its payment method for the online auction transactions).

Several approaches are helpful for practitioners to design network effects for platform business models, including the network canvas of Walter (2022), a knowledge collection by Currier (2021) of challenges and characteristics observed in creating network effects, network effect strategies of Parker et al. (2016) to overcome the platform's chicken-egg-problem, and a summary of design problems by Tura et al. (2017) for platform design and core decisions to create network effects. Although the literature provides strategies and frameworks that can be used to conceptualize network effects for platform design, we see a gap in approaches to designing network effects for platform business models.

3. Research design

In this paper, we present an approach called the NfX Construction Guide and explore whether virtuous cycles of network effects can be designed systematically. The conceptualization of network effects for platform business models can be considered a design problem and thus a case of Design Science (Tura et al., 2017). In Design Science, the research interest lies in designing and investigating artifacts in a specific context in order to improve a given problem. In our case, we could use an action research approach (Wieringa, 2014) focusing on the design process of an artifact, e.g., the designing of a virtuous cycle of network.

3.1. Technical action research: a research instrument for design science

As we are investigating the NfX Construction Guide approach to explore the design of comprehensive network effects for platform business models, we are looking for practical experiences to formulate reflective lessons. Therefore, we apply the TAR cycle shown in Fig. 1. The illustration of the figure is inspired by (da Silva Torres, Fantinato, Branco, & Gordijn, 2021)

The TAR cycle shown in Fig. 1 consists of the *problem statement* (1), our *treatment design* to address the problem raised (2), the actual *treatment* in our use case (3), and the validation of the treatment (4). Our TAR cycle begins with the problem statement and the associated research question (subchapter 3.2). The application of the TAR cycle (chapter 4) includes the treatment design (subchapter 4.1) with an explanation of the NfX Construction Guide approach and an example illustration of the approach for the well-known Uber Ride platform. Following the treatment design, we chose a real-life use case from a research project that focuses on a platform for digital solutions to improve public services in rural areas. The authors of this paper participated in this project and conceptualized platform network effects using the NfX Construction Guide approach. The experience and insights gained can be used by practitioners and scholars seeking to design virtuous cycles of network effects for platform business models (subchapter 4.2). The validation of the NfX Construction Guide results is based on direct observation and expert interviews (subchapter 4.3). Finally, our experiences are translated into lessons learned (chapter 5).

3.2. Problem statement

The importance of network effects for two-sided markets has already been demonstrated by Parker and Van Alstyne (2005) and Parker et al. (2016). Furthermore, several articles have already shown links between network effects and actions that trigger the emergence of these effects by the asset broker. For example, according to Parente et al. (2018), executives have pointed out that investing Uber's marketing efforts in geographically dense locations worldwide is crucial for the creation of network effects between drivers (asset providers) and passengers (asset consumers). Thus, it can be assumed that the marketing actions performed by the Uber platform provider (asset broker) can lead to a

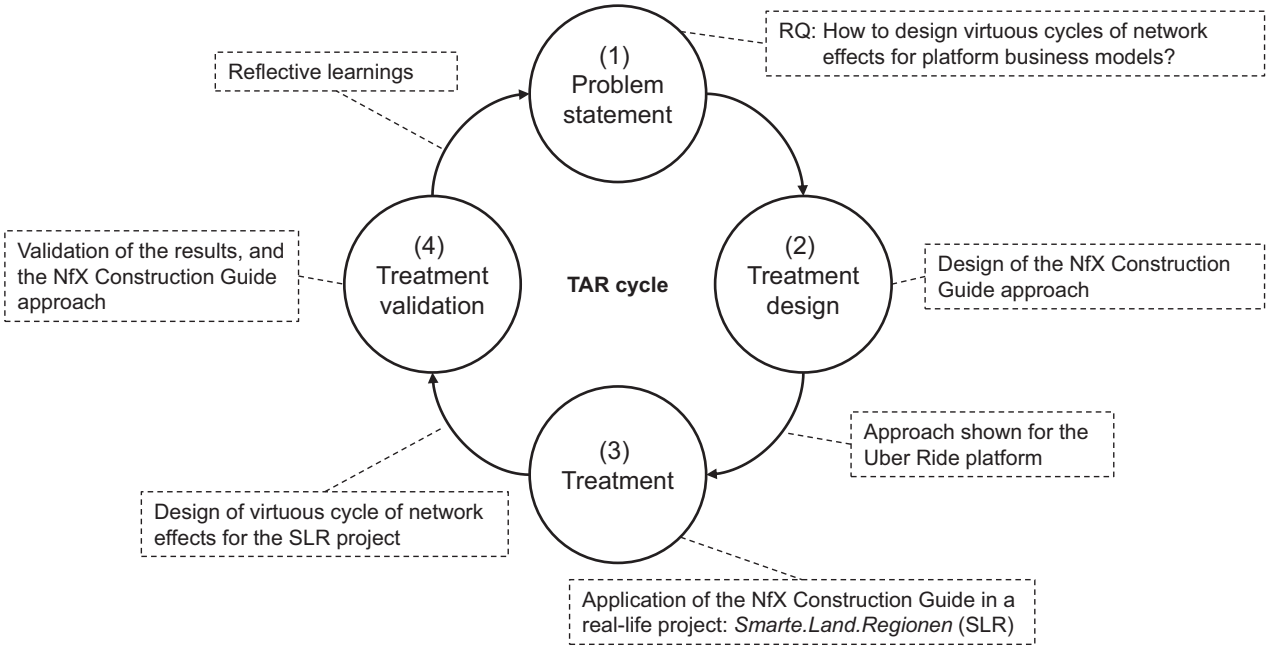


Fig. 1. Research design.

growing number of consumers and providers, which positively reinforces network effects. Another relation is demonstrated by (Watanabe et al., 2016) in terms of a virtuous cycle between the decrease in prices and the increase in the number of trips for Uber: If Uber actively lowers prices per ride, e.g., through discount promotions, an increasing number of bookings can be expected on the consumer side. These and other demonstrated relations show causalities in the sense of a *virtuous cycle of network effects*, representing a cycle between two-sided markets and their self-reinforcing network effects.

An established representation of a virtuous cycle of network effects has not been shown in the literature yet, but a well-known visualization of a virtuous cycle of network effects is pointed out by Parker et al. (2016), and shown by Sacks (2014), who drew Uber's key success strategy and virtuous cycle on a napkin (Fig. 2).

Although the figure is hand-drawn and minimalist, it has a great deal of significance when it comes to explaining Uber's strategy and how it creates value based on indirect network effects between providers and consumers of a platform business model. Sack's drawing represents the influence between the two market sides – "more demand" from passengers and "more drivers" – as well as a causal chain of effects between the two market sides, such as "faster pick-ups" leading to (→) "more demand". Based on this, we asked ourselves how these virtuous cycles can be designed systematically for other platform business models, and whether the proposed approach can be used to transfer existing design knowledge on network effects.

The objective of this paper is to validate the usefulness of the proposed NfX Construction Guide approach for designing network effects for platform business models. Our problem statement refers to Tura et al., 2017, who pointed out the core design problem of network effects for platform design and how network effects work. We summarize our problem statement in the following research question: *How to design virtuous cycles of network effects for platform business models?*

4. Applying the technical research action cycle

The intention of the NfX Construction Guide is, in particular, to support practitioners from industry who want inspiration for building network effects. The approach covers startups and young companies that want to position themselves well strategically from the beginning on their way to becoming successful asset brokers of a digital platform. The NfX Construction Guide is also suitable for already established companies that want to reposition or restructure themselves in terms of their platform business model and also their network effects.

4.1. Treatment design: NfX construction guide

The NfX Construction Guide approach comprises four steps and enables systematic development of network effects for two-sided markets. In addition, the NfX Construction Guide also serves as a basis for scholars to expand and further develop the tool concept of network effects. Finally, it serves as inspiration for the development of further tools to help build business models. Fig. 3 describes these four core steps.

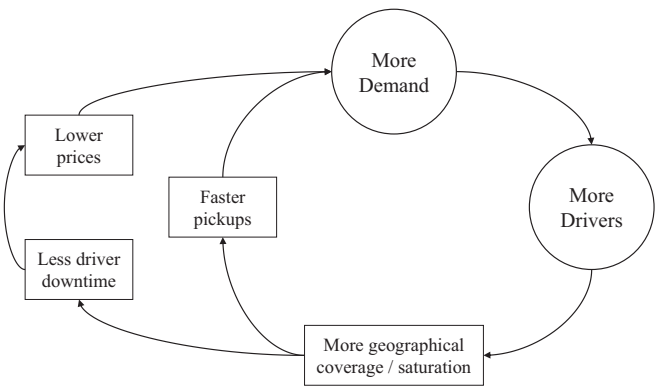


Fig. 2. Uber's virtuous cycle (Sacks, 2014).

The steps shown in Fig. 3 illustrate the step-by-step expansion of the NfX Construction Guide. Each step includes relevant aspects for the modeling process. The strategies presented in the NfX-Box (step 2) give practitioners guidance in finding network effects that are suitable for them and the impetus to develop new ideas. The NfX-Box represents the core element of the NfX Construction Guide and is a construction kit for developing strategies that supports the generation of values and the development process of the intended network effects.

4.2. Step 1: Answer the four starter questions

To get the most out of the NfX Construction Guide, four aspects of the digital ecosystem service enabled by the digital platform need to be broadly clear at the beginning. Consequently, the first step is to answer the following four core questions, as shown in Table 1, using the Uber Ride platform as an example.

4.3. Step 2: Determine marketing, onboarding, and retention strategies

In the second step, the focus is on the provider and consumer journey and the development of strategies that identify a subgroup (level 1), make the target groups on both sides of the market aware of the digital platform (level 2), persuade them to actually use the digital platform (level 3), and keep them on the platform for the long term (level 4). For this purpose, we provide a morphological box, called NfX-Box, with four levels and appropriate guiding questions from the asset broker's point of view:

- Level 1 – Target Group: Which asset providers and asset consumers do I focus on?
- Level 2 – Awareness: How do I attract the attention of my asset providers and asset consumers?
- Level 3 – Onboarding: How do I convince my asset providers and asset consumers to participate in the digital platform?
- Level 4 – Retention: How do I retain my asset providers and asset consumers in the long term?

For each level, the NfX-Box provides various strategies (example extracts in Table 2) that help to find appropriate ways to overcome the raised questions. The strategies are concrete marketing measures that trigger ideas for answering the questions. Each strategy is structured as a *pattern* that comprises a name, a description, and an example to make it as understandable as possible. A pattern comprises a proven and accepted solution to a recurring problem in a given context (Klose, 2002), and is thus a proven approach for formalizing and capturing accepted design knowledge about network effects.

Pattern approaches are generally quite popular and are often used in requirements engineering, software design, and business modeling (see, e.g., the Gang of Four book (Gamma, Helm, Johnson, & Vlissides, 1994), Interaction Design (Borchers, 2008), and 55 Business Model Patterns (Gassmann, Frankenberger, & Csik, 2014). An example of design knowledge for platform business models is shown by Caillaud & Jullien (2003), who solves a monetization problem of indirect network effects with a "divide-and-conquer" strategy – subsidizing the participation of one side (divide) and recovering the loss on the other side (conquer). We propose a pattern-based approach to find strategies for designing positive cycles of network effects for platform business models.

The aim of this second step is to develop strategies that address both the asset provider and asset consumer of the digital platform. Besides Level 1, the user can choose up to three strategies or add their own strategy and combine them as needed. Levels 1 to 4 should be applied for both market sides. In compiling the strategies, we have used various sources such as the patterns of the Business Model Navigator (Gassmann

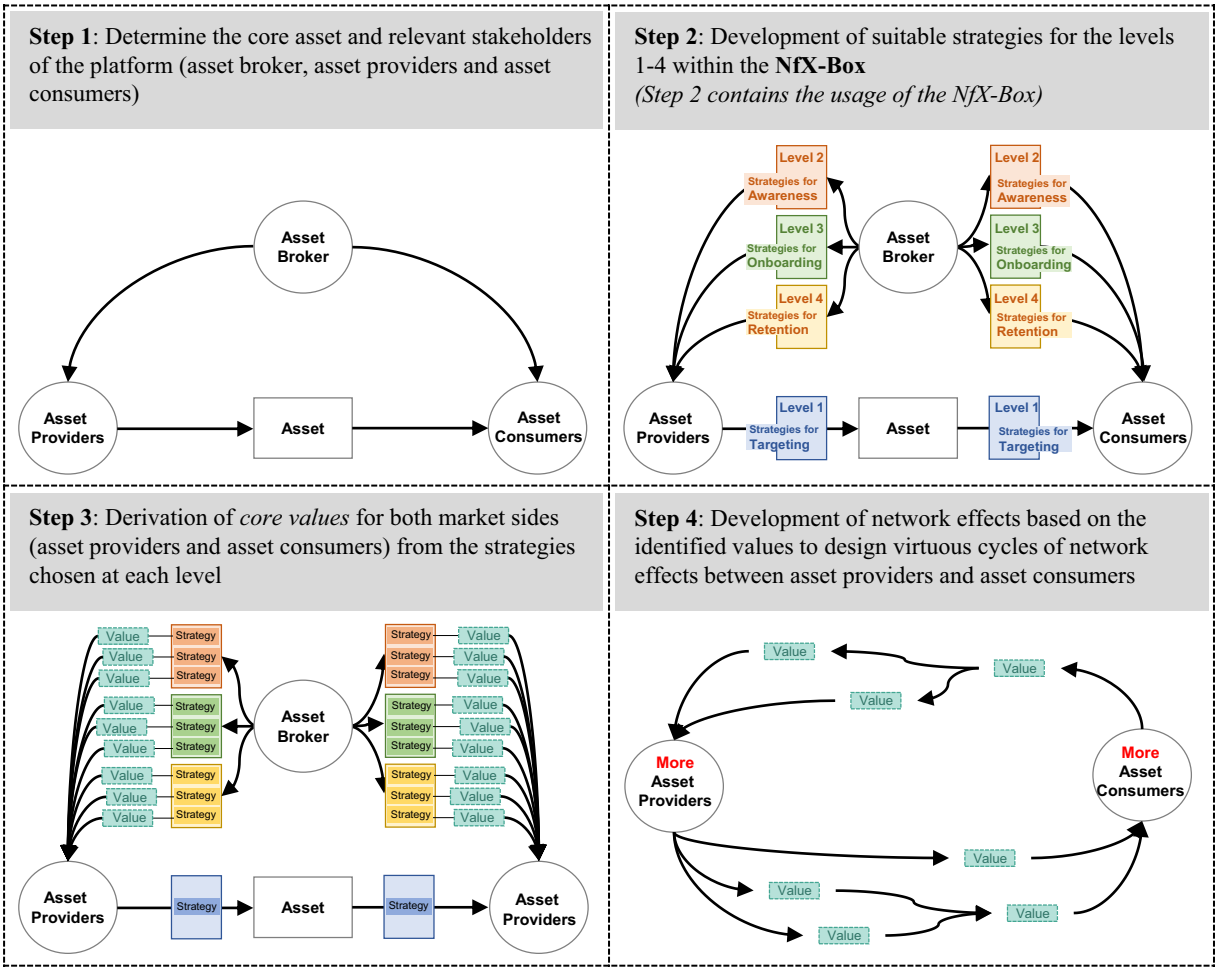


Fig. 3. Presentation of the NfX Construction Guide approach and its four steps.

Table 1
Core questions of the NfX construction guide.

Core questions of Step 1	Exemplary answered for the Uber Ride platform
(1) Who is the asset broker of my digital platform?	Asset broker of the Uber Ride platform is *Uber*.
(2) What type of asset does my digital ecosystem service focus on?	Uber's digital ecosystem service focuses on the brokering of *rides* between asset providers and asset consumers.
(3) Who are the asset providers of my digital platform?	Asset providers of the Uber Ride platform are *drivers*.
(4) Who are the asset consumers of my digital platform?	Asset consumers of the Uber Ride platform are *passengers*.

et al., 2014), the Business Model Matrix (Bartels, 2021) and the NFX Bible (Currier, 2019). These pattern approaches provide a starting point for our pattern-based NfX-Box to design strategies for virtuous cycles of network effects. To illustrate which patterns we used to provide trigger strategies for the NfX-Box, we provide a list of 47 patterns for the provider side and 48 patterns for the consumer side online.[2] The defined patterns have been classified by us and represent a collection of already described strategies and do not claim to be complete, but can be flexibly extended and adapted. The application of the NfX-Box and strategies are presented in this chapter using the example of Uber. To illustrate the core idea of the NfX-Box, Table 2 represents a simplified version.

[2] https://doi.org/10.5281/zenodo.7063024

Level 1 of the NfX-Box: Specific strategies help to narrow down the properties and characteristics of the asset providers and asset consumers and define them in more detail. The focus should be on one strategy because you should focus on one target group with one specific characteristic.

Example of Level 1 described for Uber (Kalanick, 2015).	
Asset Providers:	Uber *focused* on experienced *drivers* from existing limo services to build up a supplier market side [Strategy P1.2].
Asset Consumers:	Uber *focused* on *regional passengers* (passengers in San Francisco) to build up a demand market side [Strategy C1.1]

Level 2 of the NfX-Box: Specific strategies help to attract the attention of asset providers and asset consumers. Choose up to three strategies. Otherwise, there is a risk of selecting too many strategies and losing focus of the really important ones. This also makes it possible to cleverly combine the selected strategies with each other.

Example of Level 2 described for Uber (Brazil & Kirk, 2016; Rahman, Yuliati, & Simanjuntak, 2019).	
Asset Providers:	Uber attracts drivers with various *local media activities* in cities where it has launched its service [Strategy P2.3].
Asset Consumers:	Uber *attracts passengers* through word-of-mouth activities. Therefore, Uber offers *Affiliate Programs* [Strategy C2.2].

Level 3 of the NfX-Box: Specific strategies help to onboard providers and consumers to the platform. Choose up to three strategies. Otherwise, there is a risk of selecting too many strategies and losing focus of the really important ones. This also makes it possible to cleverly combine

Table 2
Illustration of the four levels of the NfX-Box.

Supply side of the platform (asset providers)				Demand side of the platform (asset consumers)			
Level 1: *Which asset providers does the asset broker **focus on**?*				**Level 1**: *Which asset consumers does the asset broker **focus on**?*			
Strategy P1.1 Asset broker focuses on **regional** providers	**Strategy P1.2** Asset broker focuses on **experienced** providers	**Strategy P1.3** Asset broker focuses on **large** providers	**…** (On this level, you can choose between 8 strategies)	**Strategy C1.1** Asset Broker focuses on **regional** consumers	**Strategy C1.2** Asset Broker focuses on **frugal** consumers	**Strategy C1.3** Asset Broker focuses on **large** consumers	**…** (On this level, you can choose between 8 strategies)
Level 2: *How does the asset broker **attract** the attention of asset providers?*				**Level 2**: *How does the asset broker **attract** the attention of asset consumers?*			
Strategy P2.1 **Cross- Selling** offers with external partners	**Strategy P2.2** **Affiliate Programs**: providers attract providers	**Strategy P2.3** **Local advertising** in newspapers, on the radio, etc.	**…** (On this level, you can choose between 16 strategies)	**Strategy C2.1** **Cross-Selling** offers with external partners	**Strategy 2.2** **Affiliate Programs**: consumers attract consumers	**Strategy C2.3** **Local advertising** in newspapers, on the radio, etc.	**…** (On this level, you can choose between 16 strategies)
Level 3: *How does the asset broker **convince** asset providers to participate in the platform?*				**Level 3**: *How does the asset broker **convince** asset consumers to participate in the platform?*			
Strategy P3.1 Asset broker convinces with a **free trial**	**Strategy P3.2** Asset broker convinces with a **sign-up bonus**	**Strategy P3.3** Asset broker convinces through special **assistance & support**	**…** (On this level, you can choose between 10 strategies)	**Strategy C3.1** Asset Broker convinces with a **free trial**	**Strategy C3.2** Asset Broker convinces with a **sign-up bonus**	**Strategy C3.3** Asset Broker convinces through special **assistance & support**	**…** (On this level, you can choose between 10 strategies)
Level 4: *How does the asset broker **retain** asset providers in the long term?*				**Level 4**: *How does the asset broker **retain** asset consumers in the long term?*			
Strategy P4.1 Provider retention through **special rewards**	**Strategy P4.2** Provider retention through **network events**	**Strategy P4.3** Provider retention through **discount programs**	**…** (On this level, you can choose between 10 strategies)	**Strategy C4.1** Consumer retention through **special rewards**	**Strategy C4.2** Consumer retention through **recurring push notifications**	**Strategy C4.3** Consumer retention through **discount programs**	**…** (On this level, you can choose between 10 strategies)

the selected strategies with each other.

Example of Level 3 described for Uber.	
Asset Providers:	Uber (2021a) *convinces* new *drivers* to use the platform by offering a *sign-up bonus* via promo code when they register [Strategy P3.2].
Asset Consumers:	Uber (2021b) *convinces* new *passengers* to use the platform by offering a *sign-up bonus* distributed over the first four rides [Strategy C3.2].

Level 4 of the NfX-Box: Specific strategies help to encourage providers and consumers to stay on the digital platform. Choose up to three strategies**.** Otherwise, there is a risk of selecting too many strategies and losing focus of the really important ones. This also makes it possible to cleverly combine the selected strategies with each other.

Example of Level 4 described for Uber.	
Asset Providers:	Uber (2021c) *retains* its *drivers* by offering special *rewards* through a loyalty program called "Uber Pro" [Strategy P4.1].
Asset Consumers:	Uber *retains* its *passengers* by using *recurring push notifications* with promo events [Strategy C4.2].

Based on the strategies developed in Step 2 within the NfX-Box, the values for the considered market sides are derived in Step 3 and used in Step 4 as a basis for designing a network effect cycle.

4.4. Step 3: Generate direct network effects within each market side

The objective of step 3 is to derive corresponding values from the selected strategies of the NfX-Box for both the asset providers and asset consumers. The identified values and linkages between each market side and the asset broker represent the direct network effects because the derived values mainly influence the needs of one market side. Any chosen strategy used by an asset broker should result in at least one value for the asset providers or asset consumers of the digital platform. Likewise, it is possible that several strategies lead to the same value. For example, the value "user can save money in the long term" can be derived from the retention strategy "*customer loyalty*: economic retention through *discount programs* for long-time customers" or also from the onboarding strategy "*sign-up bonus*: new registered users receive a welcome bonus". When determining the values, it is helpful to take the perspective of the considered asset provider and asset consumer and ask what types of values (e.g. economic, hedonistic or ecological values) can be offered through the use of the digital platform. Using Uber as an example, step 3 can be described as shown in Table 3.

Step 4: Generate indirect network effects. The core idea of step 4 is based on the question of how growth on the provider side can increase growth on the consumer side and vice versa. The approach answers this question on the basis of the elaborated values. For each value, it should be discussed to what extent it can be supported by the other side of the market. This may result in new values. Values that do not enable a cycle with two-sided network effects can be removed.

In the end, the completed model has to be revised creatively and

Table 3
Example of uber to illustrate step 3 of the NfX construction guide.

Used marketing strategies of Uber		Derived values
How does Uber attract new drivers? Uber attracts drivers with various local media activities in cities where it has launched its service.	*leads to*	Drivers can earn money.
How does Uber attract new passengers? Uber attracts passengers with various local media activities in cities where it has launched its service.	*leads to*	Passengers get a greater geographic coverage of the Uber service, resulting in faster pickups.
Used onboarding strategies of Uber		
How does Uber convince new drivers? Uber convinces new drivers to use the platform by offering a sign-up bonus via promo code when they register.	*leads to*	Drivers can earn more money.
How does Uber convince new passengers? Uber convinces new passengers to use the platform by offering a sign-up bonus distributed over the first four rides.	*leads to*	Passengers get lower prices.
Used retention strategies of Uber		
How does Uber convince new drivers? Uber retains its drivers by offering special rewards through a loyal-ty program called "Uber Pro".	*leads to*	Drivers can perform more trips through a "proof of quality".
How does Uber convince new passengers? Uber retains its passengers by offering new features that improve quality of its matching.	*leads to*	Passengers are picked up more quickly.

checked for meaningfulness. If necessary, new values can be added again. Finally, it is a matter of reviewing the *big picture* to see whether two-sided network effects have been designed successfully. It is also important to check the economic viability, i.e., whether the modeled network effects are sustainable and will work without constant push by the asset broker. If the asset broker has to intervene constantly to trigger network effects, then the designed model is not sustainable. The derived virtuous cycle of network effects for the Uber Ride platform is shown in Fig. 4.

4.5. Treatment: designing network effects for the SLR platform

4.5.1. Use case of SLR – digital platform for public services

After proving our approach with the Uber Ride platform, we present the NfX Construction Guide for a platform design within a research project called Smarte.Land.Regionen (SLR). This research project aims to improve public services in rural areas through digital technologies. For this purpose, a digital ecosystem is being created, centered around a digital platform – referred to in this paper as the SLR platform. For the realization of the SLR ecosystem, the following stakeholders relevant to the digital platform will be considered:

- **Software companies** can be understood as organizations that *provide* software solutions (including hardware extensions, if needed) for the digital platform. Examples include mobility solutions or software for reserving public spaces for citizens to improve well-being in rural areas.
- **Counties** are the administrative units and act as *consumers* on the digital platform requesting digital solutions for their citizens.
- **Citizens** are the inhabitants of a county and should be understood as potential end users of digital solutions.
- The **SLR platform provider** is understood as the actor responsible for the development and operation of the digital platform and takes over all activities for the realization of the digital ecosystem.

Based on this stakeholder grouping, two market sides can be derived for the digital platform of the SLR project, as shown in Fig. 5.

In Fig. 5, the (1) solution providers represent the provider side on the digital platform, offering various digital solutions to meet the needs of individual counties and their citizens. The (2) counties and the (3) citizens are understood as the consumer side of the digital platform, who obtain digital solutions on the digital platform and are users of the digital solutions. Counties and citizens differ here in that, counties demand digital solutions for their citizens, who in turn can use them in rural areas.

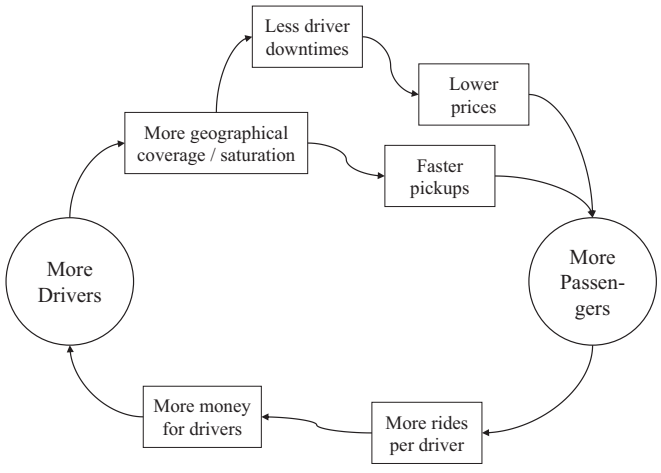


Fig. 4. Virtuous cycle of network effects for Uber Ride's platform business model.

4.5.2. NfX construction guide applied to the SLR platform

Based on the vision of the SLR project, all relevant roles for the actors could be identified and the market sides defined. Tables 4 to 8 illustrate each step of the NfX Construction Guide for designing virtuous cycles of network effects for the platform business model of the SLR project.

Step 1: Answer the four starter questions

The four core questions of the digital ecosystem service enabled by the digital platform should be clear and are presented in Table 4.

Step 2: Determine marketing, onboarding, and retention strategies

The second step focuses on targeting, marketing, onboarding, and retention strategies. This involves defining an initial *target group* specifically for solution providers and counties (level 1) and making them *aware* of the SLR platform (level 2), *engaging* them in using the SLR platform (level 3), and *retaining* them on the SLR platform for the long term (level 4). For this purpose, we used the NfX-Box to pick out appropriate strategies for both market sides from the asset broker point of view. SLR Ltd. as the asset broker has to design each level for both market sides, as the two stakeholder groups have to be addressed individually (see Tables 5 and 6).

Explanation for level 1: Targeting. To determine an initial target group of solution providers, the SLR Ltd. (asset broker) chooses two strategies: *industry-specific providers,* who are already established in a relevant problem field (e.g., mobility), and *old-hands providers*, who already have business experience working with public-sector clients (e.g., counties).

Explanation for level 2: Marketing. SLR Ltd. addresses new solution providers through *direct sales*, *cross selling* and *rent-out-a-shelf*. Through face-to-face meetings at public conventions (e.g., German Smart Country Convention), SLR Ltd. introduces the platform to solution providers and shows them how to adapt their digital solutions to the digital platform. Here, SLR Ltd. could show new solution providers how they can combine their digital solution on the SLR platform with other digital solutions to develop new, innovative sales channels. In addition, the asset broker can organize events and offer spaces where new solution providers can showcase their current solutions to individual counties, thereby giving them the opportunity to increase their visibility.

Explanation for level 3: Onboarding. With the *payment* strategy, SLR Ltd. can encourage selected solution providers to register on the platform by paying them a registration bonus for offering digital solutions. In addition, with the second strategy, *content registration*, SLR Ltd. can plan to motivate new solution providers to join its platform by providing them with reports and exclusive information, e.g., "Local citizen satisfaction index" or "Top 5 mobility problems in counties in southern Germany".

Explanation for level 4: Retention. With the help of the *contractual lock-in* strategy, the platform operator could bind the solution providers to the platform by agreeing minimum contract periods for the digital solutions offered. In addition, the SLR platform operator can use the *VIP status* strategy and give special awards for highly innovative and successful solutions, which can be used by the solution providers for their own reputation.

Explanation for level 1: Targeting. With the *giant user* strategy, the SLR Ltd. focuses on counties with more than 60,000 inhabitants. Larger counties directly generate more users and have more funds to use the digital platform.

Explanation for level 2: Marketing. As part of *direct sales*, SLR Ltd. wants to meet the mayors of the counties in person, contact them by e-mail or set up information booths in the communities to present the digital platform. With marketing strategies via *events*, SLR Ltd. wants to address county-specific problem areas (e.g., mobility) and promote *specialized* solutions of solution providers.

Explanation for level 3: Onboarding. SLR Ltd. uses the *testing phase* strategy to provide counties with free access to solutions on the digital platform. Counties can test digital solutions and try them out for their needs. In addition, a comprehensive *support service* is offered to help counties get started with the platform easily. If a county uses the test phase, SLR Ltd. offers a *quantity discount* strategy. If counties book a

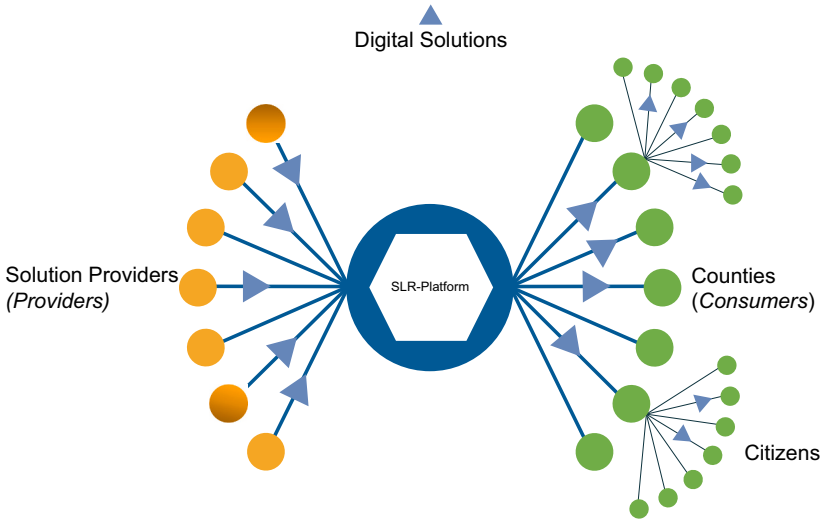


Fig. 5. SLR platform and the two market sides.

Table 4
Step 1: core questions of the nfx construction guide.

Core questions of Step 1	Example answered for the SLR platform
(1) Who is the asset broker of my digital platform?	The asset broker of the SLR platform is the platform provider, namely *SLR Ltd.*.
(2) What type of asset does my digital ecosystem service focus on?	SLR Ltd.'s digital ecosystem service focuses on the brokering of *digital solutions* between asset providers and asset consumers.
(3) Who are the asset providers of my digital platform?	Asset providers of the SLR platform are software companies, i.e., *solution providers*
(4) Who are the asset consumers of my digital platform?	Asset consumers of the SLR platform are *counties*.

digital solution directly for more than 20% of their communities, a discount of 10% off the total price is granted.

Explanation for level 4: Retention. SLR Ltd. can organize exclusive *networking-events* with counties to gather county needs and feedback. This should give the counties the feeling of being taken seriously and of feeling valued, in order to increase the emotional bond to the digital platform (*network care*). In addition, SLR Ltd. could establish its platform as a brand, e.g., *SLR for County Care*. Counties that make the digital platform available to citizens can increase their visibility and portray themselves as particularly caring. In addition, SLR Ltd. can award *VIP-status* for special citizen friendliness and special commitment of the counties to SLR.

Step 3: Generate direct network effects within each market side

In step 3, we derived corresponding values from the selected strategies of the NfX-Box for both solution providers and counties to create direct network effects. As Tables 7 and 8 show, not every chosen strategy used by SLR Ltd. resulted in at least one value for the solution providers or counties. Additionally, it can be seen that several strategies lead to the same value.

Step 4: Generate indirect network effects

In step four, we discussed for each value whether and how it can be supported by the other side of the market. This did, on the one hand, lead to new values (e.g., "more satisfied counties and citizens") and, on the other hand, to the deletion or adjustment of values that do not lead to indirect network effects (e.g., "low platform hurdles and barriers for bookings"). The derived virtuous cycle of network effects for the SLR platform is shown in Fig. 6.

This step is an iterative creative process in which the values derived from Tables 7 and 8 are the starting point for modeling a virtuous cycle of mutually reinforcing values.

Table 5
Step 2: marketing, onboarding, and retention strategies for solution providers.

Level 1: Targeting	
Targeting *Industry-specific Providers*	The asset broker focuses on a specific industry in order to target the best known, the most exclusive or the cheapest providers within the industry.
Targeting *Old Hands*	The asset broker focuses on asset providers who already have knowledge in the field, as well as experience, resources, or skills that are useful and easy to transfer.
Level 2: Marketing	
Independent Marketing via *Direct Sales*	The asset broker draws attention to the platform by approaching the asset providers directly, without interposing a partner. This intensifies the relationship with the asset providers.
Partner-based Marketing via *Cross-Selling*	The asset broker draws attention to its platform by expanding it via its own complementary products / services. This makes better use of both existing relationships and the company's own resources and capabilities.
Partner-based Marketing via *Rent-out-a-Shelf*	The asset broker draws attention to its platform by creating comprehensive marketing areas for potential partners. In this way, the platform draws the attention of asset providers who were not necessarily in the previous focus.
Level 3: Onboarding	
Incentive to Participate via *Payment*	The asset broker convinces its asset providers to participate in the platform by paying the asset providers for their participation.
Incentive to Participate via *Content Registration*	The asset broker convinces its asset providers to participate in the platform by offering exclusive content for registration. Asset providers who want to receive more content must then register on the platform.
Level 4: Retention	
Contractual Bond via *Contractual Lock-in*	The asset broker binds its asset providers through contractual ties, thereby making it difficult to switch to other asset brokers.
Emotional Bond via *VIP Status*	The asset broker binds its asset providers by granting awards for essential asset providers, which in turn enable exclusive access and functions.

4.6. Treatment validation

The validation of the NfX Construction Guide was conducted with experts from the research institution Fraunhofer Institute for Experimental Software Engineering (IESE) in Kaiserslautern, Germany. We

Table 6
Step 2: marketing, onboarding, and retention strategies for counties.

Level 1: Targeting	
Independent Marketing via *Giant User*	The asset broker focuses on the market's largest, best-known, and most influential asset consumers, so that further asset consumers feel addressed by pull effects.
Level 2: Marketing	
Independent Marketing via *Direct Sales*	The asset broker draws attention to its platform by approaching the asset consumers directly, without interposing a partner. This intensifies the relationship with the asset consumers.
Independent Marketing via *Events*	The asset broker draws attention to its platform with scaled events. The asset broker thus creates a community, demonstrates activity, and obtains direct feedback. It primarily uses social media to announce events.
Partner-based Marketing via *Specialization*	The asset broker draws attention to its platform with partnerships in order to establish the platform as an integral part of an external partner's service. As a specialized platform, it penetrates the market, if necessary, without appearing as a standalone platform.
Level 3: Onboarding	
Incentive to Participate via *Testing Phases*	The asset broker convinces its asset consumers to participate in the platform by offering a trial period at a greatly reduced price or completely free of charge.
Incentive to Participate via *Quantity Discount*	The asset broker convinces its asset consumers to participate in the platform by linking discounts or rewards to the number of asset consumers using the digital platform. The more asset consumers use a solution, the more it pays off for the participants.
Incentive to Participate via *Support Service*	The asset broker convinces its asset consumers to participate in the platform by offering supporting services that help them to get onboarded as easily as possible and to use the platform quickly and easily.
Level 4: Retention	
Emotional Bond via *Networking-Events*	The asset broker binds its asset consumers by organizing creative, socially respected events such as fundraising galas or innovation days. This gives the consumers a positive experience and a good feeling about the platform.
Emotional Bond via *Network-Care*	The asset broker binds its asset consumers by offering them comprehensive care services on a mindful level so that they feel valued in the long term.
Emotional Bond via *VIP-Status*	The asset broker binds its asset consumers by awarding prizes for particularly active consumers, which in turn enable exclusive access and functions.

chose colleagues as experts so that we could observe them in a workshop environment, as our approach will be used as a creativity method in the future. Thus, we monitored the usage of our approach in settings that are close to the proposed usage. Furthermore, we chose colleagues because we know each other personally. This personal relationship helped them feel comfortable and be honest about the usefulness of the overall approach and about whether they would use the proposed NfX Construction Guide in their future creativity workshops. We acted as observers, so there were always two observers present.

In total, we discussed our approach with four experts, one female and three males, with an average age of 33.9 years (Min = 31, Max = 46, SD = 5.4). The experts, their expertise, and their responsibilities in SLR are summarized in Table 9.

The experts were selected in such a way that two areas of competence were covered: the competence area "digital platforms and ecosystems" and the area of the SLR project. Consequently, two groups were formed: Group 1 (G1) with two experts who have special expertise in digital platforms and ecosystems in general, and Group 2 (G2) with two experts who have special knowledge and responsibilities in the SLR project, but also knowledge of digital platforms and ecosystems, which are to be developed and built in the SLR context.

Table 7
Step 3: direct network effects for solution providers.

Marketing strategies used by SLR Ltd.		Values derived
SLR Ltd. attracts solution providers by talking to them face-to-face at events or via promotion points.	*leads to*	Personal contact and uncomplicated access
SLR Ltd. attracts solution providers with complementary products and services. Providers can expand their offers.	*leads to*	More opportunities for marketing, awareness, and sales
SLR Ltd. attracts solutions providers by offering web space for solution-specific and local advertising spaces.	*leads to*	
Onboarding Strategies Used by SLR Ltd.		Values Derived
SLR Ltd. convinces solutions providers to use the platform by paying them to place and offer their products and services on the platform.	*leads to*	New and guaranteed revenue streams
SLR Ltd. convinces solutions providers to use the platform by offering specific usage data of the counties and their citizens.	*leads to*	Unique information and statistics about users and customers
Retention Strategies Used by SLR Ltd.		Values Derived
SLR Ltd. retains solutions providers by establishing the SLR platform as a "County Care" brand, which stands for high-quality digital solutions in rural areas.	*leads to*	Long-term increase of CI and visibility

Table 8
Step 3: direct network effects for counties.

Marketing strategies used by SLR Ltd.		Values derived
SLR Ltd. attracts counties by visiting their communities and talking directly to citizens, e.g., at village fairs, with info buses or at personal meetings.	*leads to*	Fast and personal customer service
Onboarding Strategies Used by SLR Ltd.		**Values Derived**
SLR Ltd. convinces counties by offering an all-round service that advises them, e.g., on how to use the platform or select appropriate solutions.	*leads to*	Support, help, and personal customer service
	leads to	Easy usage of the platform for counties and citizens
	leads to	Fast integration and adaptation of solutions in counties
	leads to	Low platform hurdles and barriers for bookings → one-click-booking and cancellation
SLR Ltd. convinces counties by offering them cost-free test phases for the usage of the platform and for the usage of single solutions.	*leads to*	Skeptical or reserved counties become attentive and interested
Retention Strategies Used by SLR Ltd.		**Values Derived**
SLR Ltd. retains counties by establishing SLR as a brand and awards the "County Care" seal to all counties that participate in the platform.	*leads to*	Skeptical or reserved counties become attentive and interested

4.6.1. Validation design

Our validation design for the NfX Construction Guide was based on the approach proposed by Poulson, Ashby, & Richardson (1996): direct observation as a qualitative analysis for product evaluations. Direct observation, also known as observational study, is a method of gathering information that allows observers to observe the user in the environment in which the product is normally used. Observations are useful approaches when a process or a specific event needs to be understood, a concrete outcome or product exists, and other data collection methods seem inappropriate.

At the beginning of each session, the experts were informed that they were being observed. In order to adequately document each observation, we did not use a video camera, but rather conducted each session in

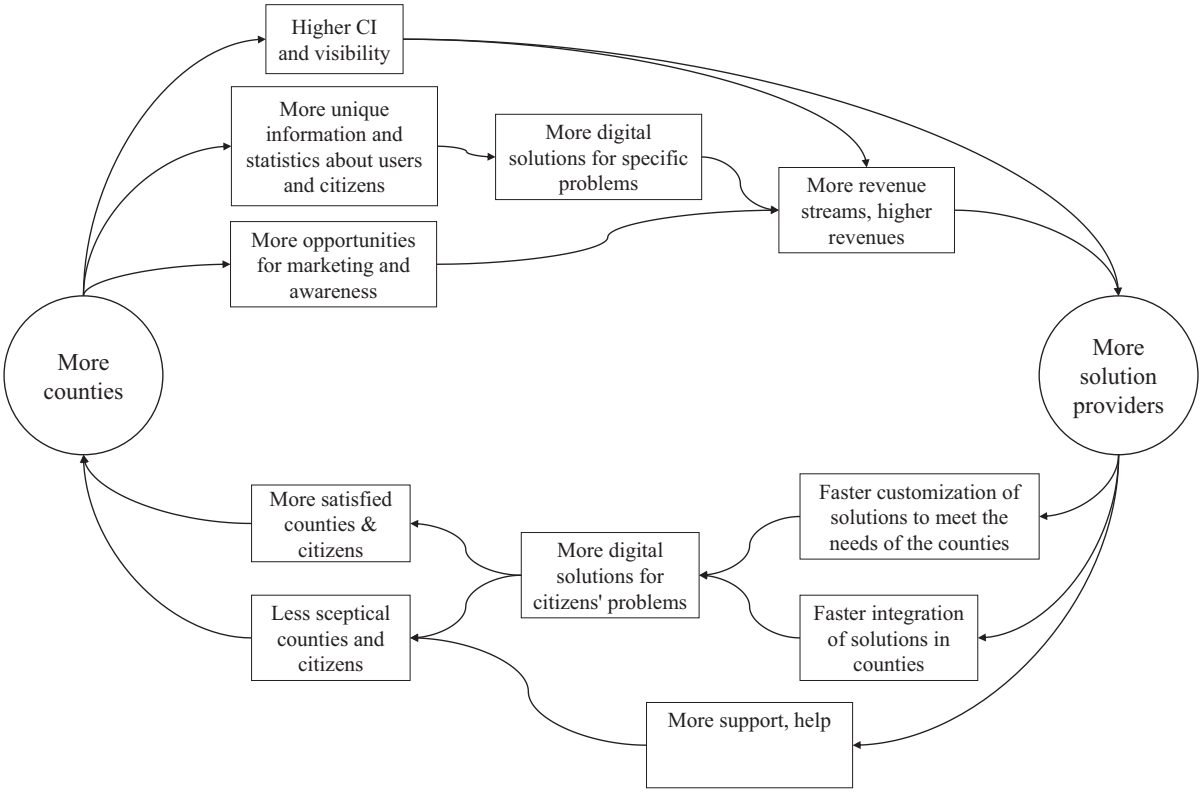


Fig. 6. Virtuous cycle of network effects for the SLR platform business model.

Table 9
Experts for the validation.

Experts	Expertise	Responsibility in SLR
Expert 1	Requirements Engineering, Digital Platform, Digital Ecosystem	Requirements Engineering concerning the platform, business model, operator model
Expert 2	Digital Platform, Digital Ecosystem, Digital Ecosystem Design	–
Expert 3	Digital Platform, Digital Ecosystem, Digital Ecosystem Design	–
Expert 4	Smart Regions and Smart Cities	Project Manager

pairs, with one examiner acting as a moderator to actively guide the conversation with the expert, while the second examiner took on the role of passive observer in order to document relevant feedback. Even though this introduced a high degree of subjectivity into the process, we were also aware of the so-called Hawthorne Effect, which states that users perform better under observation because of the attention paid to them.

Since the validation was conducted during the Covid-19 pandemic, meetings were held via MS Teams video calls and Miro was used as a virtual concept board. Thus, all outputs produced by the experts could be captured virtually. In addition, field notes were taken to record observations during the sessions in a narrative or descriptive style. Each session lasted two hours. We conducted the direct observation sessions with the experts successively, so after each validation, we revised our approach on the basis of the corresponding feedback. Afterwards, we presented it to the next expert. The procedure of our validation for each session is described below:

(1) *Introduction to the validation*. We explained the purpose and approach of the NfX Construction Guide, including the four steps for developing network effects for platform business models.
(2) *Example demonstration of the approach*. To make the approach more understandable for the experts, we demonstrated Uber as an example for the NfX Construction Guide.
(3) *Task description for G1 and G2*. We gave the experts of G1 the task of designing network effects for the planned SLR platform using the NfX Construction Guide. Since the experts of G2 are not familiar with the SLR project, an alternative project was used that also dealt with the development of a digital platform.
(4) *Feedback and closing interview*. In a final interview, the experts gave us feedback on each step of the approach as well as on the overall NfX Construction Guide.

Altogether, the validation procedure was applied four times, each time with one of the experts mentioned above. First, we conducted the validation with an expert from the field of digital platforms and ecosystems (G2), then continued our second and third sessions with the two experts from the SLR project (G1), and finalized our fourth and last session again with a platform expert. The overall validation design focused on a balance between general and context-specific feedback. All results together allowed us to validate whether our approach was appropriate for the project context of SLR specifically, but also for digital platforms and ecosystems in general.

4.6.2. Validation results

The NfX Construction Guide was validated by the experts as a promising approach to designing network effects for platform business models. It remains open whether full agreement can be reached regarding the defined research question, but the tendency appears to be positive, that the NfX-Construction Guide can be used to design virtuous cycles of network effects for platform business models.

The approach provides a structured way of designing network effects

step-by-step through the four steps. There was consensus that there is a general lack of practical approaches to designing network effects. Whether the NfX Construction Guide can be used as a practical approach to close this gap must be tested further in the future. As part of this, the approach should also be elaborated into a complete method, e.g. by working out time constraints or more detailed workshop instructions. The approach should also be used in group work to allow critical discussions about network effects ideas and to challenge decisions made. This would require a comprehensive workshop concept. The question also arises at which moment the NfX Construction Guide should be applied, e.g., whether a fully elaborated platform business model must exist or whether the results of the NfX Construction Guide can be used as input for the design process of a business model.

The NfX Construction Guide has raised a number of discussion points that cannot be answered based on current knowledge. Based on the identified discussion points, two main topics can be highlighted: (1) Platform business models are faced with the challenge of building both sides of the market: that of asset providers and that of asset consumers. The asset broker and the platform provider must therefore use strategies to address their asset providers and asset consumers until a critical mass of users has been reached. While the NfX-Box offers a number of strategies, it is unclear which strategies are best for the asset broker to use. (2) Network effects and the platform business model have strong interdependencies. The NfX Construction Guide proposes deriving the value created by a digital platform and relating it to its network effects. However, it is unclear to what extent the value proposition of a digital platform for its participants influences network effects and vice versa.

In conclusion, the results of the validation have shown that there is currently a lack of examples of virtuous cycles of network effects, as shown by Sacks (2014) for Uber. More sound examples of virtuous cycles of network effects would increase the usefulness of the overall approach and also contribute to a better understanding of network effects in the design process in general.

5. Reflective learnings

We divided the expert's feedback, and our lessons learned into three categories: (A) *feedback on general approach*, (B) *discussion points and open questions*, (C) *feedback for future work*. In category (A), we aggregated comments regarding the application and structure of the NfX Construction Guide. In category (B), we collected open questions and feedback that may help improve the approach and should be discussed. Category (C) summarized all aspects that should be integrated as next steps and future work. After each session, a list of suggestions, challenges, and problems was created that could be used for improvements. The discussion rounds at the end of each session helped us to prioritize the created list. Table 10 shows relevant results as suggestions, challenges, and problems.

In summary, the reflective learnings show that the approach of the NfX Construction Guide can potentially be used for designing network effects for platform business models in two-sided markets. We confirm the importance of network effects for value creation in platform business models (Parker et al., 2016) but based on the gained experience, we raise the question of the strategic relationship between a platform business model and its network effects. The conceptualization of network effects should be considered in the business strategy of digital platforms, and the evolvement of a platform business model and its change should be constantly adjusted in its virtuous cycles of network effects – the launch of a digital platform and the chicken-and-egg problem, and the change of business strategy once the critical mass of users is reached. At this point, the NfX Construction Guide can help the modeler systematically conceptualize different platform strategies that can be used to align the platform business model and its value creation. However, more experience is needed on what strategies to use in platform business models to successfully achieve network effects in the different phases of a digital platform.

Table 10
Reflective learnings based on the classified validation results.

(A) General approach	(B) Discussion points	(C) Feedback for future work
(A1) Timelines. If the approach is to be expanded as a workshop method, there should be timelines per step (e.g., setting a timer)	***(B1) Change of network effects.*** How do network effects differ at the beginning of a new platform business model compared to an already established platform business model? How do the selected strategies of the platform operator change (e.g., critical mass not reached vs. reached)?	***(C1) Platform services.*** The approach should be used not only for the digital platform itself, but also for services offered on the platform (e.g., payment service).
(A2) Group work. The approach should be used in a group to share thoughts and discuss ideas, especially during strategy selection in the NfX-Box.	***(B2) Impact on chicken-egg problem.*** What impact do the designed network effects have on the chicken-egg problem? How can connections be understood?	***(C2) Testing.*** The approach should be tested during different phases of the platform business model (during the development process of the platform, after 1 year of ongoing platform operation, after 3 years, etc.) to check how network effects can change.
(A3) Business model pitch. Before using the NfX Construction Guide, a kind of business model pitch should be worked out (e.g., Business Model Canvas) to check what impact the network effects have on the business model description.	***(B3) Evaluation of results.*** How can the designed virtuous cycle of network effects be evaluated? Are the designed network effects sustainable?	***(C3) Different virtuous cycles.*** The approach (especially the NfX-Box from step 2), should be applied several times with different groups. The results could be summarized to see which were the most common network effects and which is the best NfX cycle.
(A4) Note existing ideas. All existing network effects ideas for the planned platform business model should be written down first, and then new ideas should be elaborated through the approach.	***(B4) Moment of application.*** At what point in the business model development process should the approach be used?	***(C4) Missing examples.*** More examples need to be elaborated to show potential network effects of platform business models.
–	***(B5) Workshop method.*** How exactly can the NfX Construction Guide be used as a method in creativity workshops (e.g., step-by-step guide)?	***(C5) Negative network effects.*** The approach should include not only positive network effects but also negative network effects and their impact on the virtuous cycle.

6. Conclusion

We presented an approach for designing network effects for use on digital platforms that operate in two-sided markets. It consists of four steps, with the core of the approach being the NfX-Box in Step 2, with its four levels of target group determination, marketing, onboarding, and customer retention. It is the starting point for the initial creation of direct network effects, from which indirect network effects are subsequently generated. However, the approach in its entirety is still in the early stages of development.[3] Four experts from the field of digital platforms and ecosystems and the field of SLR validated and tested the approach. However, it is also clear that there are still some points in need of discussion as well as improvement. For example, it has not yet

[3] Available at https://miro.com/app/board/o9J_l9e_XQ4=/ (password: NfXConstructionGuide2022).

been validated at which point in the business model development process the approach should be used. However, we note that the NfX Construction Guide can be seen as a supplement, respectively an inherent part, of the business model. Additionally, we assume (1) that you already need to know what your digital platform and asset is about and (2) that a first rough business model including revenues etc. must already exist before using our approach.

Likewise, when using the approach, we must always consider the interaction between the product or service itself (here: the asset) and what is built around the product (the digital platform), as well as the impact and changes of the market. In order to further develop the approach and test it on concrete projects / examples, we are currently evaluating it in the SLR project by applying it to five different solutions at different points in time in their development stages.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgments

The research was conducted as part of the Smarte.Land.Regionen project. This research was funded by the Federal Ministry of Food and Agriculture in Germany (BMEL) under the Funding reference number 2818SL001. Fraunhofer IESE is responsible for the implementation of the research project. We thank Steffen Heß, Claudia Nass-Bauer, Marcus Trapp, Matthias Koch, and Matthias Berg for scientific discussions and Sonnhild Namingha for linguistic revision.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.digbus.2022.100044.

References

Aigrain, P., Chan, L., Guédon, J.-C., Willinsky, J., & Benkler, Y. (2008). The wealth of networks. *Policy Futures in Education, 6*(2), 152–175. https://doi.org/10.2304/pfie.2008.6.2.152

Bartels, N. (2021). The business model matrix: A kit for designing and innovating business models. *Journal of Business Models, 9*(3), 14–23. https://doi.org/10.5278/jbm.v9i3.6239

Bartels, N., & Gordijn, J. (2022). A Business model construction kit for platform business models - research preview. In V. Gervasi, & A. Vogelsang (Eds.), *13216. Requirements Engineering: Foundation for Software Quality. REFSQ 2022. Lecture Notes in Computer Science*. Cham: Springer. https://doi.org/10.1007/978-3-030-98464-9_14.

Benkler, Y. (2017). The wealth of networks. *Yale University Press.*. https://doi.org/10.12987/9780300127232

Borchers, J. O. (2008). A pattern approach to interaction design. In S. Gill (Ed.), *Cognition, Communication and Interaction. Human-Computer Interaction Series*. London: Springer. https://doi.org/10.1145/347642.347795.

Brazil, N., & Kirk, D. (2016). Uber and metropolitan traffic fatalities in the United States. *American Journal of Epidemiology, 184*(3), 192–198. https://doi.org/10.1145/347642.347795

Caillaud, B., & Jullien, B. (2003). Chicken & Egg: Competition among Intermediation Service Providers. *The RAND Journal of Economics, 34*(2), 309–328. https://doi.org/10.2307/1593720

Clements, M. (2004). Direct and indirect network effects: Are they equivalent? *International Journal of Industrial Organization, 22*(5), 633–645. https://doi.org/10.1016/j.ijindorg.2004.01.003

Currier, J. (2019). The Network Effects Bible. available at: https://www.nfx.com/post/network-effects-bible/.

Currier, J. (2021). The Network Effects Manual: 16 Different Network Effects - 2022. Available at: https://www.nfx.com/post/network-effects-manual/.

Cusumano, M. A. (2015). How traditional firms must compete in the sharing economy. *Communications of the ACM, 58*, 32–34. https://doi.org/10.1145/2688487

da Silva Torres, I., Fantinato, M., Branco, G. M., & Gordijn, J. (2021). Design Guidelines to Derive an e3valuee3value Business Model from a BPMN Process Model in the Financial Securities Sector. In Estefanía Serral, Janis Stirna, Jolita Ralyté, & Jānis Grabis (Eds.), *432. The Practice of Enterprise Modeling. PoEM 2021. Lecture Notes in Business Information Processing* (pp. 153–167). Cham: Springer.

Evans, D., & Schmalensee, R. (2008). Markets with two-sided platform. *Issues in competition law and policy (ABA Section of Antitrust Law), 1*(28), 667–693. Available at SSRN https://ssrn.com/abstract=1094820.

Evans, D. S., & Schmalensee, R. (2010). Failure to launch: Critical mass in platform businesses. *Review of Network Economics, 9*(4), 1–26. http://hdl.handle.net/1721.1/76685.

Gamma, E., Helm, R., Johnson, R., & Vlissides, J. M. (1994). *Design patterns: Elements of reusable object-oriented software*. Boston: Addison-Wesley Professional.

Gassmann, O., Frankenberger, K., & Csik, M. (2014). *The Business Model Navigator. 2014*. London: Pearson PLC.

Gawer, A. (2014). Bridging differing perspectives on technological platforms: Toward an integrative framework. *Research Policy, 43*, 1239–1249. https://doi.org/10.1016/j.respol.2014.03.006

Hagemeister, F. (2009). *Optimale nichtlineare Preise für zweiseitige Märkte*. PhD Thesis. Cologne: Cologne University.

Hagiu, A. (2004). *"Two-Sided Platforms: Pricing and Social Efficiency - Extensions", Discussion papers 04036*. Research Institute of Economy, Trade and Industry (RIETI).

Hendler, J., & Golbeck, J. (2008). Metcalfe's law, web 2.0, and the semantic web. *Journal of Web Semantics, 6*, 14–20. https://doi.org/10.1016/j.websem.2007.11.008

Jung, S., Wortmann, F., Bronner, W., & Gassmann, O. (2021). *Platform economy: Converging IoT platforms and ecosystems*. New York: Springer International Publishing. https://doi.org/10.1007/978-3-030-76897-3_2

Kalanick, T. (2015). *Fireside Chat With Travis Kalanick And Marc Benioff* [Interview]. Marc Benioff with Travis Kalanick. available at: https://www.salesforce.com/video/183626/?d=sec-takeover-1 (accessed 21 January 2022).

Katz, M. L., & Shapiro, C. (1994). Systems competition and network effects. *Journal of Economic Perspectives, 8*(2), 93–115. https://doi.org/10.1257/jep.8.2.93

Klose, M. (2002). *Design Patterns für digitale Produkte im digitalen Wirtschaftsraum [Unpublised doctoral dissertation]*. Gallen: University of St.

Koch, M., Krohmer, D., Naab, M., Rost, D., & Trapp, M. (2022). A matter of definition: Criteria for digital ecosystem. *Digital Business, 2*(2). https://doi.org/10.1016/j.digbus.2022.100027

Li, S., Liu, Y., & Bandyopadhyay, S. (2010). Network effects in online two-sided market platforms: A research note. *Decision Support Systems, 29*(2), 245–249. https://doi.org/10.1016/j.dss.2010.02.004

McIntyre, D. P., & Srinivasan, A. (2017). Networks, platforms, and strategy, emerging views and next steps. *Strategic Management Journal, 38*, 141–160. https://doi.org/10.1002/smj.2596

Navidi, Z., Nagel, K., & Winter, S. (2019). Toward identifying the critical mass in spatial two-sided markets. *Environment and Planning B Urban Analytics and City Science, 47*(9), 1704–1724. https://doi.org/10.1177/2399808319842181

Parente, R., Geleilate, J.-M., & Rong, K. (2018). The sharing economy globalization phenomenon: A research agenda. *Journal of International Management, 24*, 52–64. https://doi.org/10.1016/j.intman.2017.10.001

Parker, G., & Van Alstyne, M. (2005). Two-sided network effects: A theory of information product design. *Management Science, 51*(10), 1494–1504. https://doi.org/10.1287/mnsc.1050.0400

Parker, G., Van Alstyne, M., & Choudary, S. (2016). *Platform revolution: How networked markets are transforming the economy and how to make them work for you*. New York: WW Norton & Company.

Poulson, D., Ashby, M., & Richardson, S. (1996). *USERfit: a Practical Handbook on User Centred Design for Assistive Technology*. Brussels, Luxembourg: TIDE EC-DG XIII, ECSC-ECEAEC.

Rahman, F., Yuliati, L., & Simanjuntak, M. (2019). The influence of marketing mix and word of mouth towards brand image and usage of online bike usage. *Indonesian Journal of Business and Entrepreneurship, 5*(3), 287–298. https://doi.org/10.17358/ijbe.5.3.287

Sacks, D. (2014). Uber's virtuous cycle. Geographic density is the new network effect. In *Twitter*. available at: https://www.mckinsey.it/sites/default/files/the-urban-delivery-bet-usd-5-billion-in-venture-capital-at-risk.pdf (accessed 21 January 2021).

Sorri, K., Seppänen, M., Still, K., & Valkokari, K. (2019). Business model innovation with platform canvas. *Journal of Business Models, 7*(2), 1–13. https://doi.org/10.5278/ojs.jbm.v7i2.1966

Täuscher, K., & Laudien, S. M. (2018). Understanding platform business models: A mixed methods study of marketplaces. *European Management Journal, 36*(3), 319–329. https://doi.org/10.1016/j.emj.2017.06.005

Trischler, M., Meier, P., & Trabucchi, D. (2021). Digital platform tactics: How to implement platform strategy over time. *Journal of Business Models, 9*, 67–76. https://doi.org/10.5278/jbm.v9i1.5908

Tura, N., Kutvonen, A., & Ritala, P. (2017). Platform design framework: Conceptualisation and application. *Technology Analysis & Strategic Management, 30*(8), 881–894. https://doi.org/10.1080/09537325.2017.1390220

Tussyadiah, I. P., & Pesonen, J. (2016). Impacts of peer-to-peer accommodation use on travel patterns. *Journal of Travel Research, 55*(8), 1022–1040. https://doi.org/10.1177/0047287515608505

Uber. (2021a). Earn more with Uber. available at: https://uber-driver-reward.com/ (accessed 21 January 2022).

Uber. (2021b). Uber for Business. available at: https://www.uber.com/de/en/ (accessed 21 January 2022).

Uber. (2021c). Introducing Uber Pro. available at: https://www.uber.com/gb/en/drive/uber-pro/ (accessed 21 January 2022).

Walter, M. (2022). The Platform Innovation Kit 5.0 – The Toolset for the Platform Generation. available at: https://platforminnovationkit.com/user-guide/.

Watanabe, C., Naveed, K., & Neittaanmäki, P. (2016). Co-evolution of three mega-trends nurtures un-captured GDP – Uber's ride-sharing revolution. *Technology in Society, 46*, 164–185. https://doi.org/10.1016/j.techsoc.2016.06.004

Watanabe, C., Naveed, K., Neittaanmäki, P., & Fox, B. (2017). Consolidated challenge to social demand for resilient platforms - lessons from Uber's global expansion. *Technology in Society, 48*, 33–53. https://doi.org/10.1016/j.techsoc.2016.10.006

Wiedemer, V. (2007). *Standardisierung und Koexistenz in Netzeffektmärkten*. Siegburg: Josef Eul Verlag.

Wieringa, R. J. (2014). *Design science methodology for information systems and software engineering*. Berlin, Heidelberg: Springer.

Wirtz, J., So, K., Mody, M., Liu, S., & Chun, H. (2019). Platforms in the peer-to-peer sharing economy. *Journal of Service Management, 30*(4), 452–483. https://doi.org/10.1108/JOSM-11-2018-0369

Zhao, Y. Y., von Delft, S., Morgan-Thomas, A., & Buck, T. W. (2020). The evolution of platform business models: Exploring competitive battles in the world of platforms. *Long Range Planning, 53*(4). https://doi.org/10.1016/j.lrp.2019.101892