Digital Business 3 (2023) 100060

Contents lists available at ScienceDirect

Digital Business

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

The hope of exponential growth – Systems mapping perspective on birth of platform business

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ARTICLE INFO

Keywords:
Digital platforms
Growth dynamics
Platform business
Network effects
SMEs

ABSTRACT

The traditional pipeline-based approach to operating business is currently challenged by the platform-based approach. The research on digital platforms and platform business is well established and includes multiple different design frameworks for building platform business but they seem to lack the dynamic nature of platform design. We explore the birth of digital transaction platforms as a dynamic process to demonstrate the dynamic complexity of designing platform-based businesses. The paper presents a multiple case study focusing on the birth phases of four resource constrained start-ups. Based on literature study and theme interviews, we apply systems mapping to analyse the early growth of four digital platform ecosystems. Our findings indicate that the growth of platform-based business is a result of various self-reinforcing and balancing feedback loops, which create dynamic behaviour of the system. In the early phases of platforms lifecycle, start-ups struggle to offset the dominating feedback structures that limit the growth. These feedback structures vary based on business environment and platform design choices made by the platform company. The research contributes to academic discussion on digital business by providing empirical and theoretical insights into growth dynamics of business based on digital platforms.

1. Introduction

Some of the largest and fastest growing companies in the world at the moment are based on digital platforms. In the Fortune 500 list, the top 20 is populated by well-known platform giants like Apple, Amazon, and Alphabet. Companies that have gained rapid business growth rates also include names associated with digital platforms, like Salesforce, Dropbox and PayPal (Anderson, 2021). It seems that digital platforms provide an opportunity to gain business success on a global scale and with a very rapid speed of growth.

There is an extensive literature established on digital platforms especially in economics, strategic and technology management, and entrepreneurship. Platform business has been distinguished from traditional pipeline business and high-growth platforms have their own character traits. Success stories of famous platform "unicorns" are not only seen as titles of public magazines but have also been frequent focus in academia (Kenney & Zysman, 2019; Lehmann, Schenkenhofer, & Wirsching, 2019; Trabucchi, Talenti, & Buganza, 2019). Despite substantial gains in understanding the emergence of platforms, the research is somewhat fragmented in disciplinary silos and is lacking a broader view of strategy considerations in the context of platforms (McIntyre & Srinivasan, 2016) Many studies investigate the platform growth from perspective of limited firm-driven factors such as pricing, entry timing and quality (e.g. Rochet and Tirole (2006); Zhu and Iansiti (2012)). Some other studies take broader, detail complexity perspective, to investigate variety of variables influencing on platform growth, which fails to understand dynamic complexity of the platform emergence (Senge, 2006). Therefore, there is a need to create more comprehensive understanding on the dynamic complexity that impact on growth of the early-stage platforms (Wang & Lai, 2020).

Our study utilizes causal loop diagram method (Barbrook-Johnson & Penn, 2022; Goodman, 1999) to improve understanding on the growth dynamics of digital transaction platforms. In particular, the article sheds light on challenging growth dynamics of the early stage of start-ups with serious resource constraints. Aldrich and Ruef (2018) argue that there is a gap in understanding these "everyday entrepreneurs" since the platform research has focused mainly on "Silicon valley model of entrepreneurship" which is claimed to be distorted view.

The goal of the article is to develop explanation of how system structure is causing observed behaviour (dynamic hypothesis) of the

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https://doi.org/10.1016/j.digbus.2023.100060
Received 3 October 2022; Received in revised form 15 April 2023; Accepted 28 April 2023
Available online 29 April 2023

start-ups aiming to build early growth of their platform businesses. The article therefore aims to improve systematic understanding on structural characteristics that enable or restrain the growth (in particular self-sustaining and balancing feedback loops). This research paper is structured as follows: we introduce the related literature and the research design, then we introduce the case studies and findings. Finally, we discuss the relevant outcomes and suggest future research avenues.

2. Theoretical foundations

Platforms have been a topic of research from an economic point of view for a long time, and the literature is well established on the subject (Sanchez-Cartas & León, 2021; Trabucchi & Buganza, 2022). Business based on a platform differs from traditional, pipeline business, where value is created with physical products or services and is monetised by charging money for the products and services sold (Zhao, von Delft, Morgan-Thomas, & Buck, 2020). In a platform-based business, the value is created by the interaction on top of a platform (Choudary, 2015; Karhu & Ritala, 2021; Lan, Liu, & Dong, 2019) though platform-based businesses can also be built on non-digital platforms (an example is a shopping mall). The breakthrough of Internet and digitalisation has accelerated the platform phenomenon by enabling the creation of digitally based platforms for global markets by practically anyone with sufficient resources.

Digital platforms can be divided into transaction platforms and innovation platforms, based on their capability to create value (Evans & Gawer, 2016), or hybrids of these two types (Cusumano, Gawer, & Yoffie, 2019). *Transaction platforms* enable users operating on different sides of the platform to conduct transactions with each other (hence, the group of platform users is often referred as 'side' (Katz & Shapiro, 1985)). Without the platform, different sides would have a hard time finding one another and making the transaction. Examples include large marketplaces for sellers and buyers like Amazon, Airbnb and Uber. *Innovation platforms* provide resources (such as SDKs and APIs) to make complementary digital services on top of the platform to be consumed, examples include the smartphone platforms iOS (by Apple) and Android (by Google). Type of the platform is not necessarily fixed, and sometimes platforms evolve for example from transaction platforms to hybrid platforms while growing (Cusumano et al., 2019). Platforms can further be categorised based on number of sides interacting on the platform (one-sided, two-sided, and multisided platforms) (Evans, 2003; Hagiu & Wright, 2015). Many digital platforms start as one sided platform, and expand into multisided platform when the number of users on initial side is large enough to attract new sides onboard (Stummer, Kundisch, & Decker, 2018).

2.1. The challenge of platform emergence

What it takes to build a successful multi-sided platform has puzzled researchers and practitioners for a long time. Extant research has identified digital platforms in their early phase of lifecycle struggle to overcome the chicken and egg problem to initiate self-reinforcing growth (Evans, 2009). *Network effects* are a key concept regarding this problem: the value experienced by the users is dependent on the number of other users (Katz & Shapiro, 1985; Shapiro & Varian, 1998). The desired network effect is positive when the additional user increases value of the platform to other users (a well-known example is the telephone). However, network effect can also be negative, meaning that the increase in the number of users lowers the value to the users (example could be a congestion in a highway). Network effects can be divided into same-side network effects, or cross-side network effects (Rochet & Tirole, 2006; Stummer et al., 2018; Voigt & Hinz, 2015). Same-side network effects occur within the same side of the platform users (e.g. between buyers), while cross side effects mean the effect is between different sides (e.g. buyers and sellers) (Thies, Wessel, & Benlian, 2018). The network effects theory suggests that after reaching critical mass of users, platforms with significant positive network effects may grow very rapidly (Evans & Schmalensee, 2016). Furthermore, after a certain point of growth with enough market share gained, the dominant platforms are difficult to challenge from the gained position (Gawer, 2009). Indeed, for multisided platforms, the network effects may determine the eventual fate of the platform (Wallbach, Coleman, Elbert, & Benlian, 2019), but the initial challenge is how to reach the critical mass (Evans & Schmalensee, 2010).

In recent years, viral growth has received notable attention among platform entrepreneurs who seek rapid growth of their user base to reach critical mass. Viral growth is achieved when the users of a product/service cause, on average, more than one additional user, per existing user, to use a product or service (Fisher, Abbott, & Lyytinen, 2014). Hence, in the platform context viral growth refers to how many new users does one user bring with them on the platform (Steffen, 2020). Virality is based on spreading the word about the platform externally (Parker, Van Alstyne, & Choudary, 2016) and it takes advantage over the fact that many users are influenced by opinions of their peers (Richardson & Domingos, 2002), core users (Kim, 2018) and influencers (Müller, Mattke, & Maier, 2018). Dynamics of viral growth therefore resembles one of epidemic spread of a virus; susceptible non-users are "infected" by persons already using the platform (Kim, 2018) and if viral coefficient is high, viral growth skyrockets fast. For this reason, finding a formula for replicable viral growth has been described as a holy grail of online marketing (Hood, 2012) and virality has been studied extensively, especially in the context of social media platforms e.g. (Meng et al., 2018). However, viral growth is focused only on inflow of users and it is not automatically good for the business. Rapidly growing customer base may create various challenges related to scaling of the operations or virality may increases negative emotions and reactions against the company (Tanyildizi & Yolcu, 2020). Akpinar and Berger (2017) argue that the value of virality may be limited if it doesn't boost brand evaluation or increase purchases. Moreover, post-viral growth strategy may be even bigger question because exponential growth sooner or later slows down due to depletion of population of susceptible non-users (Salminen & Hytönen, 2012). Even though virality is sometimes understood only as add-on marketing tactics, it should be seen more as design issue. Aral and Walker (2011) argue that virality or "social contagion" are best achieved by designing viral features into products (and platforms).

Planning or designing a business based on a digital platform is called as platform design (Choudary, 2015; Parker et al., 2016; Tura, Kutvonen, & Ritala, 2018). Platform design is a complex task since successful platform and platform ecosystem has multiple possible building blocks for which the designer needs to make compromises (Koch, Krohmer, Naab, Rost, & Trapp, 2022; Tura et al., 2018)). These building blocks include, for example, the core interaction (Choudary, 2015; Parker et al., 2016), key stakeholders (Parker & Van Alstyne, 2009), platform openness (Hagiu, 2014), organizational structure (de Weck, Roos, & Magee, 2011), platform architecture (Bianco, Myllärniemi, Raatikainen, & Komssi, 2014) and governance (Karhu, Gustafsson, & Lyytinen, 2018). Body of research on design of individual components is extensive, and scholars have also presented several design frameworks (Kim & Yoo, 2019; Otto & Jarke, 2019; Tura et al., 2018) which aim to assemble a big picture from these building blocks. Although these studies have generated deep understanding about platform emergence, the view has its limitations as it is based on reductionism (i.e., studying components individually and assembling big picture from individual components). Scholars of systems sciences and systems thinkers argue that if the system is divided into small parts, the emergent properties are lost (Sterman, 2000) and therefore systems view on platform emergence is needed (Vignieri, 2021; Wang & Lai, 2020).

2.2. Systems thinking as a lens to study emergence of multi-sided platforms

System thinking is a conceptual framework grounded in system dynamics that enables to make sense of the complexity of the world (Richmond, 1994; Senge, 2006). Although the academics haven't been able to agree on the clear relationship between systems thinking and system dynamics (SD), it is commonly agreed that they both aim at understanding the dynamic behaviour of a complex system that are characterised by accumulations, feedback loops, time delays, and nonlinearity (Sterman, 2000). The fundamental premise is that the structure determines the behaviour, where the structure is embodied by the cause-effect relationships that connect different elements of the system forming feedback loops. These cause-effect relationships are visualized with causal loop diagrams, which provide a language for articulating and communicating deeper insights about complex issues (Kim, 1992; Sterman, 2000). The feedback loops are either reinforcing (i.e., generating exponential growth over time) or balancing (i.e., generating self-stabilising behaviour for the system) (Sterman, 2000).

SD research has made numerous contributions to a range of management subfields, including operations, organization behaviour, marketing, behavioural decision making, and strategy (Gary, Kunc, Morecroft, & Rockart, 2008; Zanker, Bureš, & Tučník, 2021). Researchers are also increasingly using SD to conceptualize multi-sided platforms as dynamic systems and examine how they develop endogenously through time (Ruutu, Casey, & Kotovirta, 2017). For example, SD has been used to analyse historical emergence of mobile telecommunications markets (Casey & Töyli, 2012), diffusion two-sided mobile payment platform (Wang & Lai, 2020), dynamics of competition between mobile application platforms (Arzoglou, Elo, & Nikander, 2019), and exploring drivers of success for crowdsourcing platform (Vignieri, 2020). SD is identified as an useful modelling methodology that can characterise dynamics of network effects and viral growth that impact on the platform emergence, and also identify resource accumulation and platform strategies that drive those effects and influence platform performance (Wang & Lai, 2020).

In this article, we apply systems thinking and in particular causal loop diagram method. In recent years, it has been widely used as a qualitative method for describing and analysing complex systems in various domains (Gudlaugsson, Ghanem, Dawood, Pillai, & Short, 2022; Haghighat & Hosseinichimeh, 2020; Kenzie et al., 2022; Kim, Connerton, & Park, 2021). Although the use of method in purely qualitative way is controversial among SD academic domain (Homer & Oliva, 2001) there are also proponents for qualitative system dynamics among SD practitioners and scholars (Coyle, 2000; Wolstenholme, 1999). In addition, the qualitative analysis is used as a standalone method in broader scholarly field of systems thinking and mapping. In this article our goal is to use this qualitative approach to create deeper understanding on the dynamic complexity related to emergence of native digital transaction platforms. In particular, our study aims to answer the research question:

> *What are the structural characteristics of a system (platform ecosystem), shaped by platform design choices that affect the growth dynamics of the platform*?

3. Research design

This article is based on a multiple case study to identify and analyse the different aspects affecting the business growth potential of a digital platform. Multiple cases were selected to provide a larger picture, rather than a single case (Eisenhardt, 1989; Yin, 2009). Since the study was not meant to test any specific hypothesis and the study was exploratory in nature, we have used the abductive research approach. The abductive research approach is a mixture of both inductive and deductive approaches, and is considered fruitful when the objective of research is to discover new things and relationships (Dubois & Gadde, 2002; Järvensivu & Törnroos, 2010). Following the abductive research approach, relevant literature provided a framework for the researchers to study the case companies and compare the empirical observations with theoretical implications flexibly.

3.1. Data collection

Empirical data for the study was collected from total of eight interviews focusing on four digital platforms (and respective companies). Each platform was initially studied based on available material on the Internet (web pages, press releases, news and social media) as corroborating evidence for the research (Noor, 2008). After familiarisation to each platform, interviews were conducted to discover details of emergence of each platform ecosystem as well as to discover the key capabilities and factors that had contributed to development path of the platforms. Sampling of selected platforms was based on lifecycle stage of the platform and potential access to interview founders of companies. This sampling method (Taherdoost, 2016) is considered suitable for studies of explorative in nature (Brewis, 2014). The cases and their business characteristics are illustrated in Table 1.

The data collection was conducted with theme interviews. Interviewees represented the founding members of the platform companies and interviews included one initial interview followed-up by a second in-depth interview to analyse the birth phase of the platforms. Interviews were conducted by 2–3 researchers (observer triangulation): one was leading the discussion and other(s) were writing case memos and occasionally asking focused questions. The interviewees were asked to describe the lifecycle of their platform based on three separate phases: before launch of the platform, the actual launch phase and growth path into the present moment since launch. Interviews lasted between 60 and 90 min per interview and were conducted during June 2020 – August 2021. Documents and publicly available data regarding the platforms (such as web pages and social media updates) were used to triangulate findings from the interviews to increase the validity of research (data source triangulation).

For the interview process, a thematic interview framework was utilized to guide the interviews. The interviewees in the organizations were selected based on the key informant technique and they represented central positions within the organizations (Marshall, 1996). After the first round of interviews, an audit trail procedure was used to check to validity of the interviews and the narrative account (Creswell & Miller, 2000). This was accomplished by using persons external to the research group for validity testing. After the second round of interviews, the data was subjected to validity check by using the member checking procedure (Creswell & Miller, 2000). This gave the interviewees a chance to review the data and check for possible errors or misunderstandings. The research process is illustrated in Fig. 1.

Data analysis was conducted in multiple rounds of analysis with the help of NVIVO software with an aim to identify relevant variables for system dynamic modelling. First, interview data was processed into first-order codes independently by two key researchers with a goal to break down the data into discrete parts (Saldaña, 2009). Then researchers compared the first-order codes and grouped them jointly into second order codes based on their relevance to the research question. Next, researchers continued with systems mapping (also referred as qualitative system dynamic modelling), where the main focus was on conceptualization of the system (Coyle, 2000; Coyle & Alexander, 1998). These second order codes and identified causal links formed the basis of drafting causal loop diagrams (CLDs) in Vensim. Initial CLDs were drafted with Vensim from each case with an aim to map cause and effect relationships and impacts of the variables and components of the system on one other. The goal of drafting four separate CLDs was to develop alternative theoretical explanations for identified behaviour (i.e., dynamic hypothesis) and to be able compare dominant dynamics in each of the cases. Table 2 in Appendix 1 illustrates the coding process

Table 1
Details and business characteristics of the cases.

Case	Market Type	Industry	Established	Key Value Proposition	Key Sides	Revenue Stream
Case A	Business-to-business	Manufacturing	2018	Efficient Procurement	Procurers and purchasers	Subscription fee + set-up fee
Case B	Business-to-business (B2B)	Logistics	2018	Sustainable and cost-efficient logistics	Ports, info providers and utilizers	Subscription fee
Case C	Business-to-consumer (B2C)	Retail	2011	Sustainable marketplace	Sustainably manufactured clothes sellers, buyers	Transaction fee, later also a monthly fee
Case D	B2C after pivot also B2B	Waste management	2019	Smart waste management	Waste management companies, households	Transaction fee

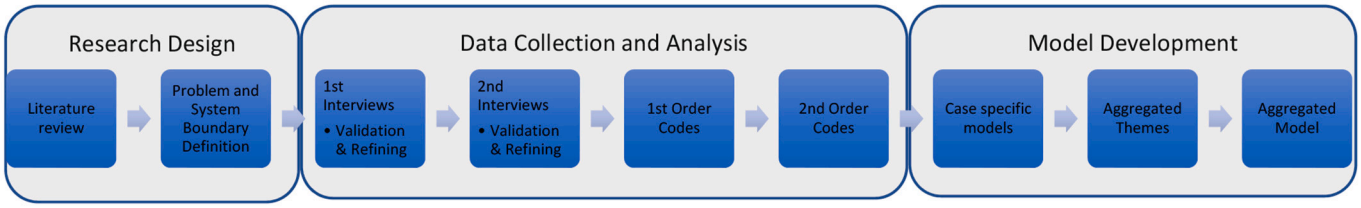

Fig. 1. The Research Process.

and provides examples of codes that were used in forming CLDs.

Case specific CLDs were elaborated over numerous iterations by comparing the model to codes, validating findings with secondary data such as press releases and social media posts and revisiting initial data when needed. Finally, the findings of four case specific CLDs were combined into a new generalized CLD. Generalization was conducted by indication main loops of each individual case diagram, combining similar loops, and removing loops that seemed to be specific to only one case.

The analysis followed abductive research approach, which is described by back-and-forth movement between data and theory. Throughout the process of system dynamic modelling, initial theories were reflected to theories identified by the literature review on platform emergence. Hence, researchers utilized theoretical triangulation (Patton, 1990) by testing new theories which might provide better and more complete explanation to the studied phenomenon. Preliminary results were introduced to fellow researchers who provided their feedback therefore ensuring investigator triangulation (Patton, 1990).

4. Findings

4.1. Case A

4.1.1. The context

The platform for case A had been established to coordinate information flow of contract manufacturing activities in machine industry. The flows included data on electronic requests for offers (RfOs) and replies to the offers between different supply chain partners. Existing solutions (different ERP-systems) were established within the industry, but they were expensive, difficult to use and were static in nature when the actual need was for a dynamic and flexible solution symptomatic for the business. The custom nature of RfOs would also cause large amounts obscurities, misunderstandings, and confusions in the supply chain.

Initial development work was done so that the platform was used in-house only in an industrial manufacturing company, to coordinate the contract manufacturing activities. Soon it was decided that there would be good reasons to spinoff the platform from the parent company. First, the idea of a digital platform would not fit into the core competence of the parent company, which was performing contract manufacturing activities. Development of the platform had used a lot of resources and, for example, the number of software development personnel had increased significantly. Also, the management and leadership needed to be separated as different skillsets (digital platform management vs. manufacturing activities management) were needed. Second, partner companies would most likely be intimidated to join a digital platform centred around one specific partner within the existing supply chain. Therefore, it was decided that a new company was to be established to pursue the development of the digital platform as a more neutral host. Assets of the platform and related resources were transferred from the parent company into the new, digital platform-based company.

4.1.2. Growth dynamics

Growth of the platform relied initially on the manufacturing company where the platform was ideated in the first place. *Initial users* on the platform became from the parent company, as well as from some of their supply chain partners. The users on the platform would offer their manufacturing capabilities as well as place requests for offers and orders through the platform. Users on the platform indicated that they would benefit from the platform the most when the existing supply chain partners would be on the platform too.

This *word-of-mouth (WOM) advertising* was hoped to create a viral growth, soon to be accelerated by network effects. Also, thanks to the pricing model of the platform, joining as a "invited user" was free for users – this would help to increase the number of users on the platform. Invited users could use the platform with partner who had invited them on the platform, but not with others. Once a customer would be onboard the platform, the repeatable action of sending and receiving offers would keep the customers on the platform. As an additional side to the platform, financing institutions had joined in to provide financial services for companies conducting business on the platform and thereby supporting the transactions performed on the platform and making the business more fluent.

After spin-out, the growth of the platform depended on traditional sales work which was consuming the resources of a newly established company. This work consisted of sales, marketing, and training services for the potential customers so that they would learn how to use the platform and experience the benefits of using the platform. The effort included contacting new users, but also converting the invited users into active, paying users. Acquisition of users to the platform was challenging as many potential customer organizations were fragmented so that different departments would not communicate inside their organizations very well. Contacting all required parties from one organization, to demonstrate the benefits of the platform to the whole organization, was a big effort. The growth dynamics for the platform in case A are illustrated as causal-loop diagrams in Fig. 2. In system dynamics, the polarity of a loop is deduced by multiplying the signs involved in the loop. If the

result is a "+," then it is a reinforcing loop (R); otherwise, it is a balancing one, (B) (Richardson, 1995).

4.2. Case B

4.2.1. The context

The platform for case B had its roots deep in the technological development of autonomous ships in the maritime industry. During the technological development work, it was identified that future of maritime shipping and logistics would not only be about intelligent and autonomous ships – it would also be about the sharing of information between parties, specifically in harbours and partners operating within the harbours. These partners would include a plethora of different actors in addition to ships, like logistics partners handling the shipping of the containers via land-based routes as well as local authorities such as custom officials. The information related to shipments generated by one party was not easily accessible by other partners in the harbours. Existing solutions for information sharing were based on separated, fragmented solutions like emails, SMS messages and phone calls. Some existing digital systems were established, but they were old legacy systems meant to support some specific harbour activities, with difficulties for access to all different partners. In addition, the harbour environment offered other potential opportunities for a digital platform, such as development of communication systems as well as simulation and planning tools. Initially employed at a maritime industrial company, the team behind the platform idea decided to spin out and the opportunity was enhanced by a change in the ownership of the parent company.

4.2.2. Growth dynamics

Based on the contacts and partner networks developed within the maritime industry, the platform company was able to get a large European harbour as a partner and a *pilot customer* to co-develop the platform with. Platform was developed according to the partner needs, focusing on sharing ship schedules and simulating ship traffic. Focus was also on making the user interface accessible and to display different activities going on in the harbour in one glance. Based on these features, the platform could be expanded to other harbours as well – as the core needs of harbours were similar.

To promote initial growth, platform with basic functionalities was offered for free to harbours in the Finnish markets, with potential premium model supporting the monetisation. The basic model for offering the platform in Finland was enabled by access to large amounts of open data in Finland related to ships and shipments via Portnet (a national, single window to ship data in Finland). The data available could be easily integrated into the platform with basic functionalities. Based on the received feedback, the platform had identified some key platform functionalities as selling points and was looking to expand to other market areas globally. The availability of different data sources for the platform varied between market areas and the wisest means of integrating those data sources were still unclear.

Outside of Finland the growth dynamics were different. Each new port environment required laborious sales efforts and extensive customisation of the platform according to each customers' technical environment. In addition to initial sales, the challenge was also to get various actors of the harbour to join the platform, which was crucial since the value of the platform increased by the number of different actors onboard. Thus, the adoption relied on sales and promotional work to spread the word in each harbour environment. This slowed down the growth of the users in each platform, as the platform company had limited resources to do such work. The growth dynamics for the platform in case B are illustrated in Fig. 3.

Similarly, as in case A, the main bottleneck for growth of platform in case B seems to be the strong reliance for traditional, resource consuming sales work including training and deployment services as the platform required customisation work. Fast growth would require extensive global sales force and availability of the local support functions. One option would be to leverage resources of international sales partners, which would solve the resource constraint of the platform company for conducting global sales. However, large scale outsourcing of sales to international sales partners may require significant financial resources and taking substantial risks, before there is evidence that this model is financially sustainable.

4.3. Case C

4.3.1. The context

The foundation of platform in case C was based on the personal needs of the founders to establish a (digital) marketplace to sell children's clothes which were produced and designed in a sustainable way and according to high ethical criteria. Existing solutions at the time were more general marketplaces (Amazon, Etsy, eBay) which didn't have a special focus on sustainably or ethically produced clothes and they were not localised to smaller market areas. Based on their initial own need, the founders discovered that other local sustainable brands would like to have access to a local digital marketplace as well.

To form a platform company, the founders participated in different trainings available for start-up companies. A graphic designer was hired to make the user interface appealing to both brands and consumers, and to support the image and brand of the platform. Founders did not have the specific technological skills needed to make a digital platform, so they decided to outsource the development work. Technologies needed to create a digital marketplace largely already existed and were available as open-source software, so the outsourcing was not a major effort. A special emphasis was placed on the curation of different brands present on the platform: extensive research including interviews with specialists were conducted to complete the criteria on how to evaluate the sustainability features of the brands present on the platform. This would make sure that customers would be safe in knowing that what they were buying was in accordance with sustainability and ethical values. The platform was co-developed with seven other companies who would join the platform in the launch.

4.3.2. Growth dynamics

After the launch, around 30 more brands joined the platform – most brands were recruited based on personal local contacts and were small, one-person companies. Initially it was assumed that a snowball-like effect would start working when brands would bring their existing customer base to the platform. However, the growth required active sales and marketing work. The platform company hired two persons as additional resources: one for sales and advertising work, as well as one to recruit new brands to the platform. The primary methods to gain growth of users (both customers and brands) were marketing and sales activities based on online advertising, blogs and the use of social media influencers. Furthermore, participation in physical events had considerable capability to gain visibility. Consumer-side users also discovered the platform via the brands present on the platform. A number of different activities, for example physical events like meet and greets, were organized among consumers and brands present on the platform, purpose was to encourage dialogue and commitment between the sides. The growth dynamics for platform in case C are illustrated in Fig. 4.

After the initial years, the user base started to grow more rapidly. This was contributed to three specific brands selling well on the platform, their success attracted new consumers. Following approximately four years of growth, the three large brands had a growing need to customize features of the platform to their own, specific needs, which were difficult to implement for firm C. Since these brands were already quite well known, had large customer base and specific needs for a platform, two of the largest brands decided to develop their own platform (web-shops that they had established). After a while, they both decided to leave the (firm C's) platform and focused on their own sales channels (B2). At the same time, third of the large brands selling on platform faced business difficulties and was forced to shut down

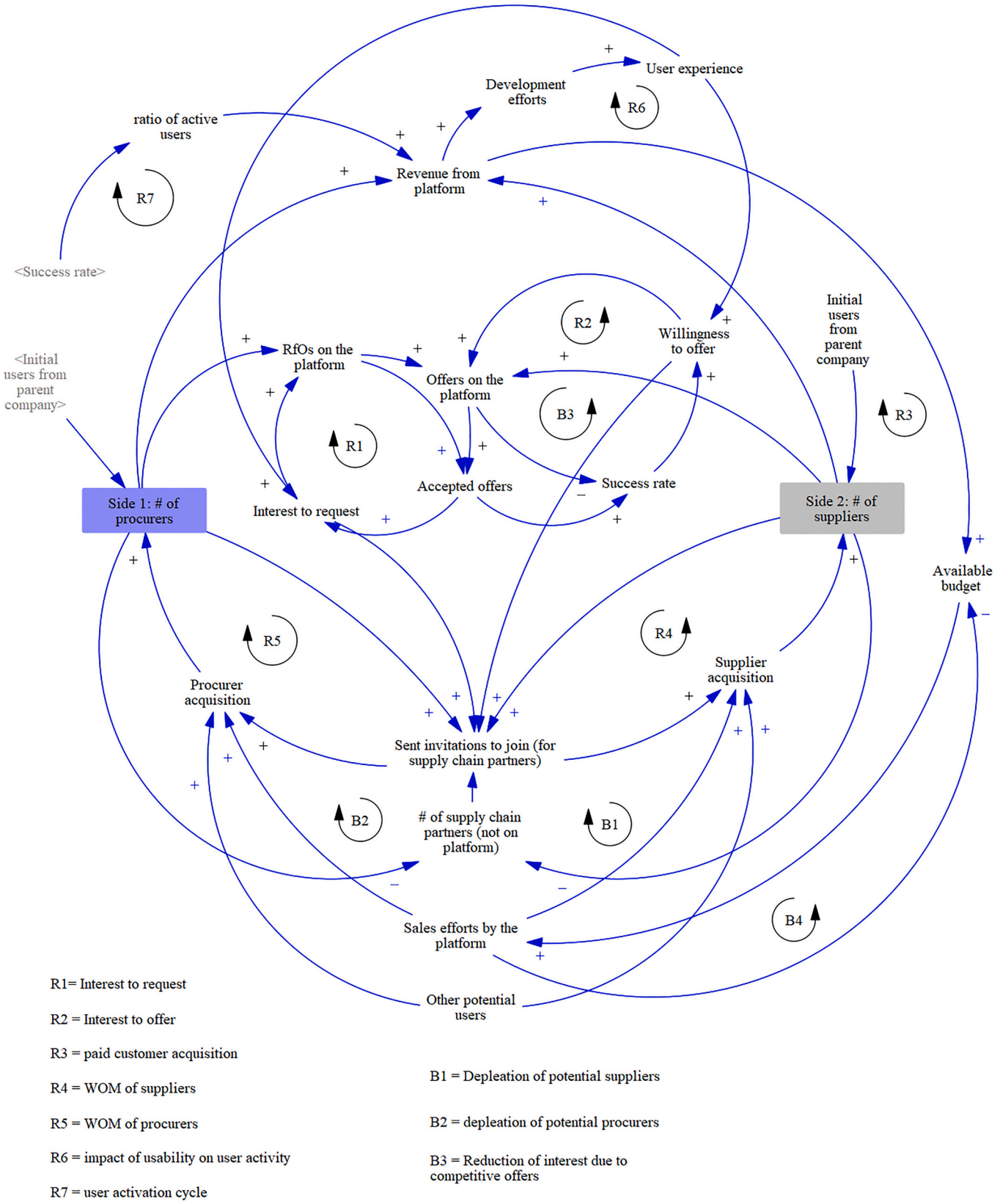

Fig. 2. Causal-loop diagram describing primary growth dynamics of case A.

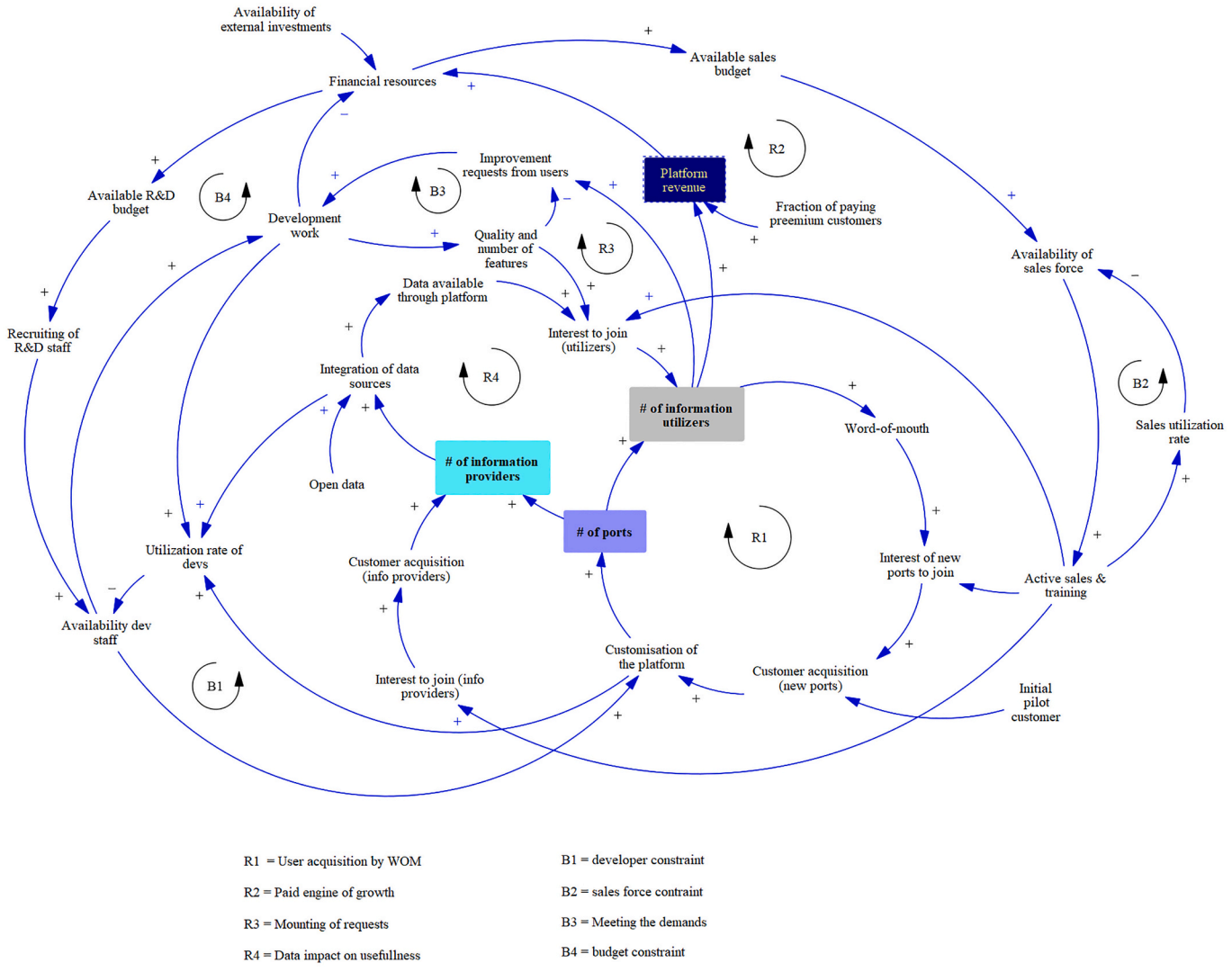

Fig. 3. Causal-loop diagram describing primary growth dynamics of case B.

operations. This meant the loss of total of three major brands, their products as well as a major portion of the brand loyal customers.

This caused a major drop in the number of users on the platform and caused the growth to regress. Losing the transactions related to the three major brands also contributed to the transaction-based revenue/income model of the platform. For the platform to recover more quickly from this setback, more (financial) resources would have been needed to bring in more users (both brands and customers). As there were no additional resources, the recovery from the setback was slow.

This setback made the platform company realise the vulnerability of the platform, and to consider introducing another source of revenue. A fixed monthly fee was introduced for the brands present on the platform, which caused even more brands to abandon the platform – however they were very small ones with little or no business going-on. Justification of the monthly fee was based on the advertising and sales work done by the platform company to get more customers visit the platform, which by this point did start to take on a brand value of its own. Despite the challenges, the platform managed to recover from the setbacks and turn the decline into growth. However, the growth has been slow without major brands and additional resources.

4.4. Case D

4.4.1. The context

The original idea for platform in case D was born in a strategy meeting of a consultancy company focusing on circular economy services. The initial idea was to help customers to seek waste management companies in their local areas and to help customers make tenders for waste collection. The solution was a digital platform which would enable households and housing cooperatives (customers) to estimate amounts of waste generated (plastics, glass, metal, biodegradable, etc.) and then sent electronic tenders to waste management companies to come and pick up the waste. The solution was influenced by other digital platforms for requesting and sending tenders for consumers (such as electrical companies, insurances, car repairs and mobile phone contracts). Technical development work of the platform was outsourced to a third-party developer, who provided the cloud-based platform based on specifications made by the founder. The platform company itself was operated by the founder who at the same time continued working in the consulting company.

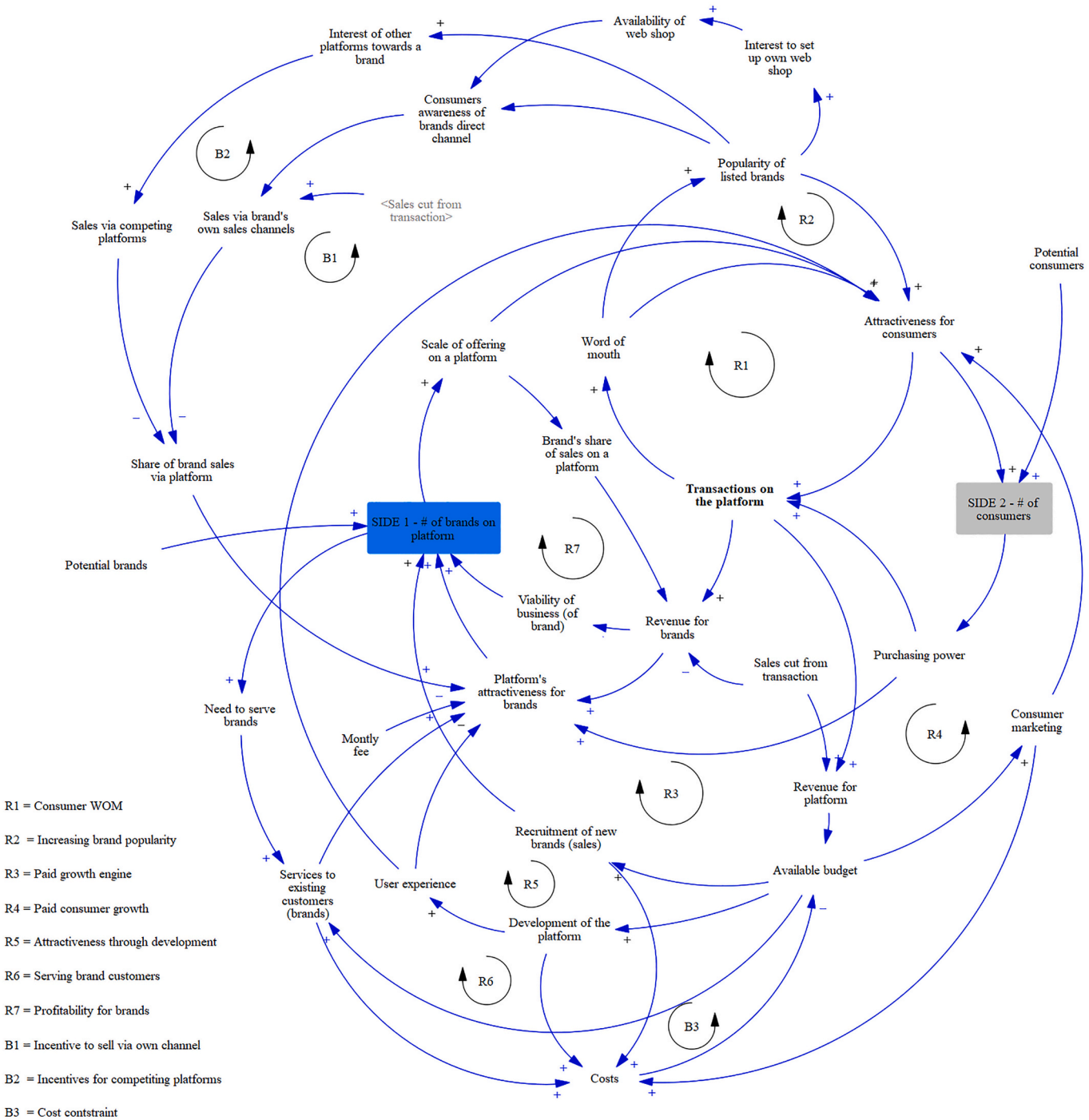

Fig. 4. Causal-loop diagram describing primary growth dynamics of case C.

4.4.2. Growth dynamics

The platform started to build customer side (households and organization sending tenders) growth with help of online advertising and search engine optimisation. In addition, they managed to attract some local municipalities to promote the platform on their respective media channels. After launch, the number of customers quickly reached over 3000, showing hints of viral growth, but the growth was still limited geographically to specific municipalities because of regulative issues. For households and organizations, the platform was free to use which contributed to the growth of the customer side.

Despite good start with the customer side, the company struggled to get the other side onboard. Waste management companies were reluctant to join the platform for a few reasons. First, the revenue model of the platform was not attractive to them in household market segment. Profit margins in waste collection of the household segment were relatively low and the waste management companies had to pay for the contracts made through the platform. Second, platform was not able attract more profitable customers (industrial organizations) on the platform. Third, the waste management companies considered direct customer interface to be a valuable asset, and therefore wished to keep the bidding process for themselves. Hence, seemingly high number of household customers on the platform did not make platform attractive enough for the waste management companies to join in. The growth dynamics of case D are illustrated in Fig. 5.

Imbalance between the sides of the platform crippled the tendering process. The platform would have needed the side of waste management companies to match the tenders made via the platform, but there was no interest. The platform company remained operated by one man and did not hire additional sales personnel. Instead of investing in growth, the platform company made a business model pivot: the platform company acquired sensor technology from a third-party provider which enabled monitoring the amount of waste in the customers' waste containers. Customers on the platform could acquire a sensor to their waste bins and the sensors would indicate via the platform when the emptying of the bins was required. This would benefit the customers so that the bins are emptied when needed, not based on a fixed pick-up schedule. The waste collection companies could now automatically optimize the routes of waste collection trucks to reduce operational expenses. Furthermore, the

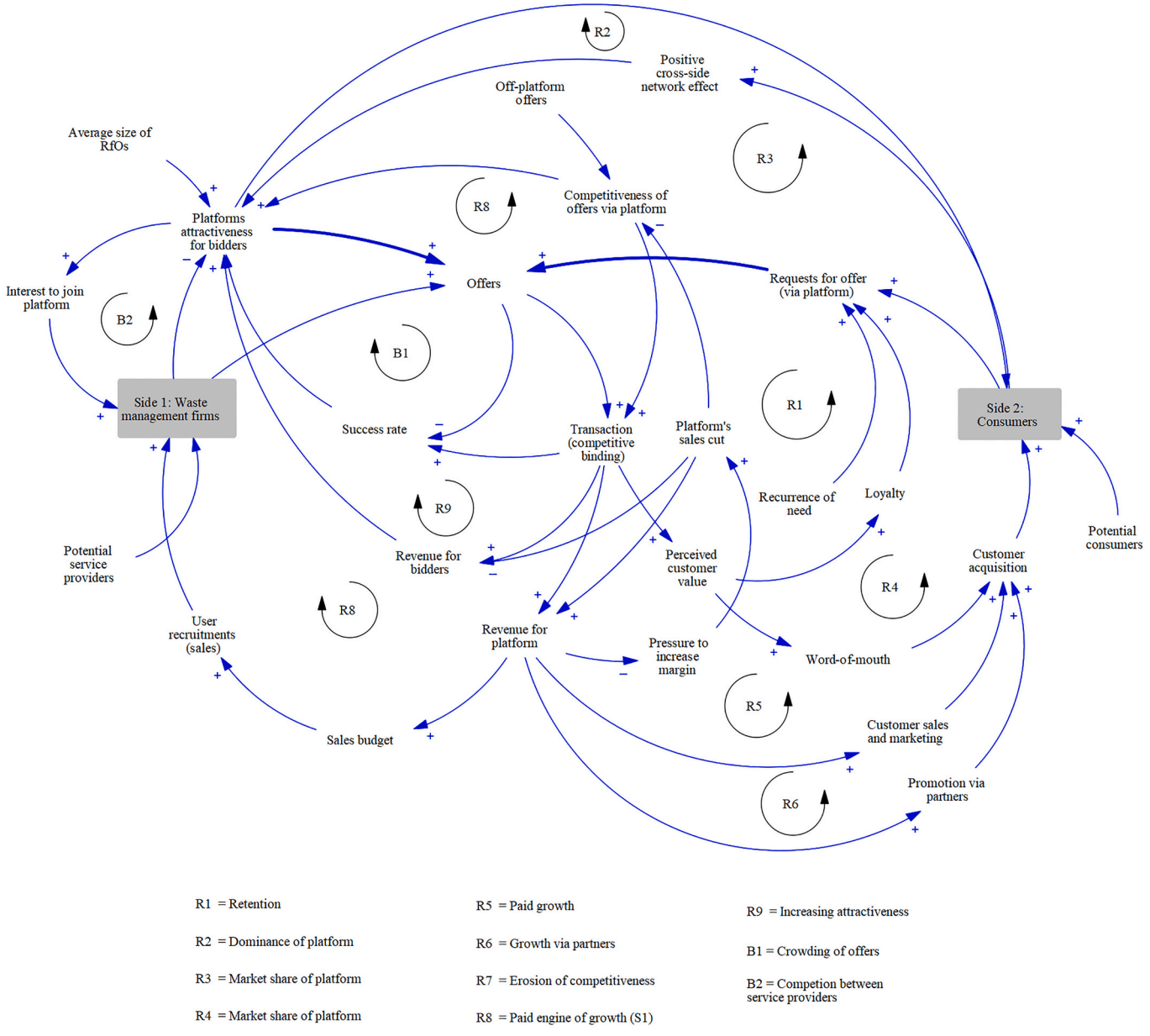

Fig. 5. Causal-loop diagram describing primary growth dynamics of case D.

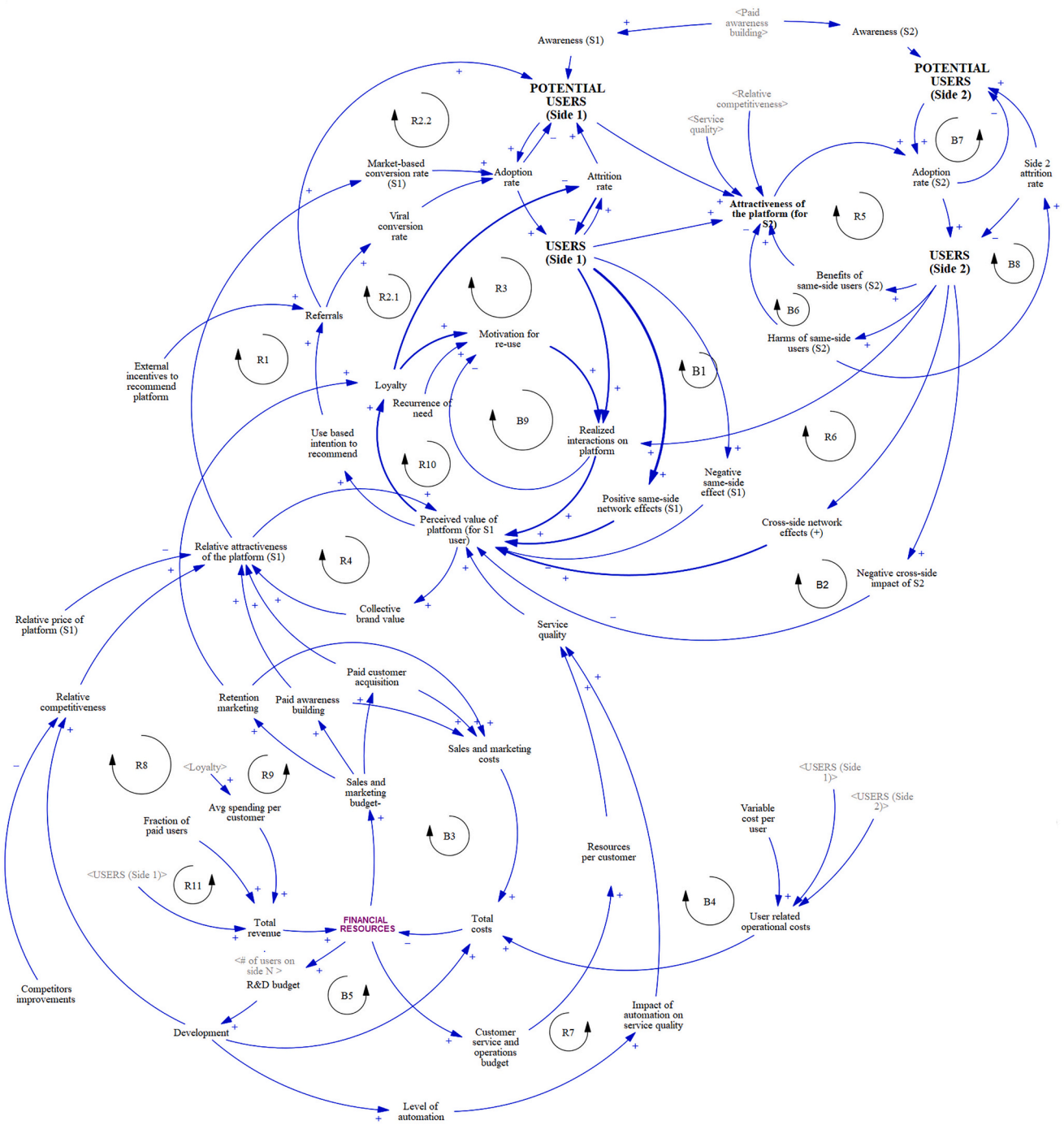

Fig. 6. A combined model for platform growth.

platform was investigating possibility to sell aggregated data from the platform to third parties regarding information related to recycling in the circular economy, thereby evolving into more of an innovation platform and into the B2B context. Since the pivot, the waste management companies started to show more interest towards the new core interaction of the platform. However, the growth was still limited to specific geographical areas partly due to regulative issues related to waste management. The new idea was tested with a few pilot customers (waste management companies) delaying large scale sales and marketing efforts. The viability of the new concept remains to be seen.

5. Case synthesis & discussion

Previous research has identified digital platforms in their early phase of lifecycle struggle to overcome the chicken and egg problem to initiate self-reinforcing growth (Evans, 2009). We utilize causal loop diagrams to analyse four case companies to provide deeper insights into the challenging dynamics of building early growth. We have combined key insights from the cases into a generalized causal loop diagram, depicted in Fig. 6. The model is a simplification (to maintain its readability) focusing mainly on reinforcing and balancing feedback loops, which share commonalities between cases and therefore form the foundations

on understanding the growth dynamics of digital transaction platforms. Even this simplified model, which focuses mainly on one side of platform, has 270 feedback loops[1] and we have named only a few of them. The main focus of the model is on the dynamic interplay between eleven self-reinforcing feedback loops (R1–11) and nine balancing loop (B1–9). Details of these loops are described in tables in Annex 1. In the following sections we discuss about the dynamic complexity these loops create.

5.1. The pursuit of snowball effect

Platform businesses are often built on a premise that once they reach a critical mass of users, these existing users on a platform generate self-sustaining growth (Parker et al., 2016). In studied cases two major effects lie behind this "snowball effect"[2]: network effects (R1) and virality (R2.1 /R2.2). In our study, mechanisms of viral growth are perhaps best visible in cases A and D thanks to word-of-mouth advertising supported by external incentives to recommend platform. Case A is an example of type of a market (collaboration platform) where viral effect is claimed to have a possibility to ignite rapid exponential growth (Hagiu & Rothman, 2016) However, it is also an example how viral growth is very challenging for platform businesses, as in that case there were too many balancing effects that decelerate the growth. In particular, the multi-sidedness of platform business creates problems if only one side grows aggressively with help of virality. This was illustrated by case D, in which the short burst of viral growth was visible on one side of the platform, but due to asymmetricity of growth, it quickly dried out.

Policy implication: *One-sided viral growth that does not ignite cross-side network effects is not likely to be sustainable and the negative effects may outweigh positive ones.*

In most of our cases, the potential of positive network effects (R1) seems evident, but the problem why it doesn't create exponential growth are manifold. First, it could be argued that the lack of network effects in studied cases is caused by the early phase of the platform lifecycle (Stummer et al., 2018). However, extant research suggests that network effects can create significant growth during very early years of a new firm (Stummer et al., 2018; Wallbach et al., 2019). On the other hand, the problem could be related to challenges of understanding the market characteristics or challenges in platform design. Especially in cases where the growth on one side does not contribute to the growth of the other side (lack of cross-side network effect (R6)) and the value of the whole platform, as was apparent in case D. On the other hand, the self-reinforcing loops can be outplayed by negative network effects (B1, B2 and B6), which can be created, for example, by overcrowding of the customer service (needed particularly in early stages of platform lifecycle). Therefore, the special focus in platform design should be placed on the dynamics between different sides, to identify the potential of network effects related to them and features of the platform all side appreciate. This will require deep insights into the characteristics of each side, something akin to market studies on customer (side) needs and users/customers jobs-to-de-done (Christensen, Hall, Dillon, & Duncan, 2016).

Another identified issue regarding network effects is that especially in B2B cases the absolute network size does not seem to be the crucial factor, but the structure of it. Afuah (2013) defines that network structure means feasibility of interactions, centrality of members, structural holes, network ties, and number of roles each member plays. Our cases A, B, and D highlight feasibility and centrality (geographical or social) of interactions. The value of the platform increases if certain close users are onboard (like supply chain partners, local waste management companies or stakeholders at local harbour), but they create very little value for other distant users. Importance of dual roles are highlighted in B2B cases, in which some early users who acted on both sides were very valuable. On the other hand, structural holes in network may require lots of efforts from the platform company to fill in.

Policy implication: *It is crucial to understand the type of transaction on which the platform business is built on and to intensify network structures (matching types of users and relationships) that are central for emergence of network effects.*

To sum up, these findings provide more details in understanding the importance of the network structure in leveraging network effects. Too uniform categorisation of the various user and relationship types is likely to provide false hope for exponential growth, which is a challenge also from the modelling perspective. Agent-based modelling tools might provide support for this, although with the downside of greater detail may come reduced readability of the models.

5.2. Retention of users

Platforms' capability to keep acquired users actively using the platform (retention R3) has major implications on the viability of the platform (Kayes & Chakareski, 2015) and is considered a basis for value creation (Amit & Zott, 2001). Extant research suggests that loyal users not only interact more, but they are also more likely to recommend others to become customers, and are also more profitable by committing a higher share of their spending to the firm (R9) (Kayes & Chakareski, 2015). Our findings suggest that the issue is more complex when looking at platforms with different growth dynamics.

Similarity between the case platforms was that at the early stages of the platform lifecycle, there was naturally relatively low number of users on each side and therefore the value generated by the network effects to existing users on the platform was very limited. To overcome this shortage, case platforms had to offer additional incentives to make the platform lucrative for customers in order to prevent them from leaving, e.g., on-site customer service, tailoring solutions for customers, discounts of usage fees and free trial periods.

We found also major differences between the cases. The recurrence of the interactions performed on the platform varied considerably, ranging from the interactions recurring daily (strong reinforcing loop R10 in cases A & B) to interactions done only once a year or in two years (strong balancing loop B9 in case D). There seems to be a difference between B2B platforms and B2C platforms. The B2B platforms had a recurring need strongly connected to a specific business as a basis for core interaction, which is considered to be a starting point of platform design (Parker et al., 2016). This meant that the users would perform it again and again (like sending and receiving offers or sharing of shipment information) and if users chose to invest in adopting the platform, they were likely to stay on the platform as switching costs would increase. The B2C platforms on the other hand were not able to lock-in customers. Although case C was able to keep some of their customers coming back to look for interesting products and good offers, one of the main problems was that they lacked mechanisms to prevent disintermediation when two interacting sides found each other. This finding supports previous research that identifies the increasing risk of intermediation when trust between two interacting sides improves (Allweins, Proesch, & Ladd, 2020; Gu & Zhu, 2020).

Policy implication: *Natural rate of recurrence of need determines the needed external incentives to keep users continuously using the platform.*

There is a close link between customer retention, business model execution (Wirtz & Lihotzky, 2003) and the platform firm's performance (Yang, Diao, & Kang, 2020). To keep users on the platform, a number of

[1] Counted by Vensim loops tool that displays a list of all feedback loops passing through the Workbench Variable.

[2] Snowball effect is a metaphor for platform growth. Effort of creating growth is compared to pushing a snowball on top of the hill. It is extremely difficult as snowball gets heavier while gathering more snow, but if you manage to push it to the top it starts rolling down on its own while gaining more speed and more mass.

different *retention strategies* and tactics may be applied, which are linked to potential revenue mechanisms (Weinstein, 2018; Wirtz & Lihotzky, 2003). Whereas tactics are expected to have short-term impact, retention strategies are more fundamental strategic choice (Weinstein, 2018). In our cases, case C applied *community retention strategy* by creating a sense of belonging into a community which in turn kept users on the platform. While this strategy may have been suitable for the platform brand image, this retention strategy may have caused the business challenges faced later. Existing literature establishes that community strategy is better suited for a business model that does not rely on direct revenue model, as community building increases users' usage duration and frequencies which are monetized better by indirect revenue models (Wirtz & Lihotzky, 2003). Cases A and B used *convenience* and *technical integration* as retention strategies to keep users on the platform performing repeated tasks, also *free services* were used by both cases as a tactics to keep early users onboard. Case D did not seem to have signs of a specific customer retention strategy before the pivot (due to the low recurrence rate of the need).

Our study supports the view that the companies need to think retention as core part of their marketing strategy as a baseline for long-term growth, rather than continuously acquiring new users to cover the 'lost' users or using short-term tactics to boost retention (Ascarza et al., 2018). However, building retention of platform-based business can be particularly challenging as the perceived value of using the platform may be low in the early phases of the platform as the number of other users is low (lack of positive same-side and cross-side network effect). This may necessitate short-term retention tactics to increase perceived value of early-stage users, in our cases this was visible as free trial periods, free training sessions and tailored services.

Policy implication*: Relying on laborious and/or costly external incentivisation is major limiting factor for growth, but it may be justified by the need to keep early customers and learn from them.*

5.3. Balancing with scarce resource

Resources are very scarce for the most of new ventures who do not fit into Silicon valley model of high-capitalization start-ups (Aldrich & Ruef, 2018). These firms face the cruel reality of balancing resources between different company activities like development, sales, marketing, and operations. The challenge is even harder for start-ups building a multi-sided platform business if they must bring at least two sides on board simultaneously. This was apparent as a growth limiting factor in our study, as all four cases were building two or more sides on the platform simultaneously. Fig. 6 illustrates three balancing feedback loops (B3, B4, B5) which can be labelled as "resource depletion".

All case companies focused heavily on user acquisition due to the presumption that certain level of users will ramp-up the growth via network effects. Bringing customer onboard the platform required a lot of resources and work effort from the case companies, especially cases A and B which were more focused on the B2B markets. This meant traditional sales work based on sales agents and training personnel, who would meet with the potential customers face to face and undertake training sessions to teach them how to access and use the platforms. Even though the digital platforms have a global reach via the Internet, these customer acquisition activities did not scale up effectively as they were geographically centred thereby limiting (balancing) the growth of the platform (B3). The B2C platforms seemed to be able to substitute consumer side sales with more cost-effective online advertising, nevertheless also their growth was limited especially by available resources for supply side customer acquisition.

Policy implication*: Plan the transformation from manual to more automated engagement of customer because it helps to prevent realization of negative network effects and depletion of resources.*

The paradox is that the more successful customer acquisition is, the more there are customers to be satisfied and customer related costs, the faster the company runs out of money. This paradox is highlighted in platform businesses which try to ramp up multiple sides at the same time. These challenges might have been solved by finding investors with deep pockets that helps entrepreneurs to go through the "death valley", the fact well understood by case companies. This might reflect the funding gap related to small and medium sized enterprises and their ability to access financing for growth and operations (Esho & Verhoef, 2018). Companies building their business on digital platforms seem to be no exception related to difficulties related to need and access to finance in comparison to traditional pipe-line businesses.

Policy implication: *Limit the number of sides to be ramped up at the same time to minimum to avoid burning out resources before reaching critical mass.*

5.4. Dynamic hypothesis and future research

Next we aim to summarize some theoretical explanations for identified behaviour (dynamic hypothesis) from the perspective of growth dynamics. Building on the case studies and reasoning visualized in generalized CLD, it seems that in the early phase of platform growth the balancing feedback loops (particularly B3, B4, B5 and B9) are dominating the reinforcing feedback loops. In particular, the reinforcing feedback loops R1, R4, R5, R6 and R10 seem to require higher number of users on board (either and/or on both sides) than expected by entrepreneurs. Due to poorly working reinforcing feedback, platforms have to use various external incentives to initiate and maintain growth, which is causing resource constraint that hinders the growth of the platform business. Even though short-term faster growth could be achieved with external stimulus, for example, by expensive sales and marketing campaigns, due to the weak retention related feedback loops the fast growth is expected to stall relatively fast – especially if the ramping up user base is not synchronous on two main sides conducting transactions.

All case companies expected the tipping point for self-sustaining growth to be reached faster than what had realized. One could argue that they may have had unrealistic expectations towards the growth. For the future research, system dynamic simulation could be constructed with specific parameters of each case to evaluate whether the tipping point should exist and with what conditions. Based on qualitative modelling we expect tipping point to deviate notably among different platform designs, where small adjustments may have significant impacts due to the complex feedback mechanisms. Understanding these non-linear growth dynamics of the specific platform designs could be extremely valuable for new start-ups. Current tools and methods used in start-up scene (e.g., lean start-up and business modelling tools) are extremely good in supporting fast learning in real-life, but the system dynamics simulations could speed up the learning process or even enable skipping some of the business model experiments therefore saving scarce resource of the start-up.

6. Conclusions

Our study suggests that understanding dynamic complexity should be crucial part of designing digital platforms. Although study on network effects has been well-established in academic literature (Shapiro & Varian, 1998) and is identified as one of the main drivers of growth for digital platforms (Parker et al., 2016) our findings suggest that dynamic complexity is greater than often identified when taken focusing solely on network effects. Network effects should not be seen as an automatic feature of platform business, but rather something enabled by (a successful) platform design which requires a thorough systems-oriented approach. Deep insights are required to understand complex structure of the system that produces its dynamic behaviour, including market characteristics, needs and behaviours of each side of the platform, and platform design choices.

Even though virality may be seen as a mechanism to rapidly increase platform's userbase, it is not necessarily a blessing for the platform company. "Silicon-valley based models" for growth, which rely on gigantic financial resources, may have diverted the mental focus from customer relationships building to new user acquisition. Yet, digital platforms are optimally designed so that the users keep using the platform continuously, building the loyalty towards the platform. If users are not staying on the platform, the resources spent are in vain as the main point is to keep the number of users growing. Thus, instead of maximizing network size, the quality of ties, roles, holes, and centrality should be key considerations in platform design.

Practical implications imply that digital platforms are a business of their own, and do not "fit" into the core business logic and culture of a traditional, pipe-line based business. Our research claims that systems thinking skills are critical when designing a platform-based business. The limitation of this study is that it is based on qualitative methodology (causal loop diagram) and it does not include (quantitative) simulation and validation stages of system dynamic modelling process (e.g. Sterman (2000)). However, the qualitative approach based on causal loop diagram is widely used methodology (e.g. Yun et al. (2016); Kenzie et al. (2022)) and it is seen as important method to increase the understanding on the complex problem (Wolstenholme, 1999) and valuable tool for policy analysis (Coyle, 2000). Nevertheless, simulation of the growth of different types of platforms is likely provide better understanding on overall behaviour of the platform businesses and is therefore seen as important step in future research of this topic. The results of this study can be seen as a boundary object (Black, 2013) and an important step towards building simulations (also known as management flight simulators), which could be extremely helpful method in avoiding some of the costly mistakes which are now discovered after failed real-life platform design experiments. Additional future research avenues could also include the examination of the next phases of the platform ecosystem development and taking mixed-methods approach on examination of what makes a platform ecosystem flourish and grow further, and what instead will diminish the ecosystems and slow the expansion.

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

The data that has been used is confidential.

Acknowledgments

This research work was supported by Business Finland funded co-innovation projects *KEKO* and *Data Markets for Sustainable Cities.*

Funded by the European Union – NextGenerationEU

Appendix 1. Appendix

Table 2
Selected examples of coding of interview data.

1st Order Codes	2nd Order Codes	Aggregated themes
• Increasing brand value brought more users • Users were asking to join our platform because they know about the brand of the platform	Growth by brand reputation	
• Companies invited their existing supply chain partners to join • Interest to join digital systems together via platform • Users on the platform spread the word within their real-life networks and ecosystems	Viral Effects	
• Presence of companies made it interesting for others to join • Critical mass needed, but difficult to achieve • Expected network effect to kick in earlier	Positive same side network effects	Snowball Effect
• Competition slowing down the growth of side x • Fear of losing customers to competitors • A few suppliers had disproportionally big influence	Negative same side network effect	
• Major brands brought in even more users, across sides • Households-side grew quickly, but it didn't have positive impact on the other side	Cross-side effects	
• The number of local suppliers is very small	Market saturation (local)	
• Community events were held to keep the customers engaged • Having existing business partners on the platform kept companies in the platform	Retention of users	
• Users returned to the platform because they liked the brands • Low brand recognition as a challenge	Attracting brand value	
• Need for frequent exchange of information via platform		Retention
• The companies in the supply chains are doing parallel, similar duties which can automated to save time	Compounding orders	
• The users made a transaction on the platform once, with no need to use it repeatedly	Lack of re-use incentive	
• Hiring a dedicated person to take care of physical events and marketing • Sales work is traditional door-to-door sales work, we need to showcase the platform and make demo-presentations	Sales & marketing spending	
• Scaling of platform very difficult with limited resources • Lack of money forced to seek cheap ways to do marketing		
• All users on the platform require engineering and customization work • Bigger we are the more resources we burn • Stakeholder auditing still needs to be done manually • Geographical expansion increased the Opex too much	Operational costs	Balancing with resource Depletion
• We cannot accommodate all feature requests of all user sides, we need to focus • Differentiate between nice-to-have and must-have • Couldn't afford to keep developer on payroll	Prioritising spending on development	

(*continued on next page*)

Table 2 (*continued*)

1st Order Codes	2nd Order Codes	Aggregated themes
• Initially we did not have paying customers at all • 20% transaction fee turned out to be way too low	(Insufficient) income streams	
• New features require SW development and engineering work • Development based on identified recurring needs	Competitive advantage through development	
• Identifying functionality that enables exponential growth • Loyal customers bought wider variety of products	Increasing spending of loyal customers	

Table 3
Causal loops related to "snowball effect".

# / name	*Flow*	*Type - Example*
Same-side loops (S1)		
R1 – Growth by network effects and brand reputation	USERS S1 ➔ Pos. same side network effects (S1) ➔ Perceived value.. (S1) ➔ Brand value ➔ Relative attractiveness.. ➔ Market-based conversion rate➔	Reinforcing – More users enhance platform's attractiveness for new users
B1 – Overcrowding of "demand-side"	USERS (S1) ➔ Negative same side effects (S1) ➔Perceived value.. ➔ Loyalty ➔	Balancing – Growing user base creates negative side-effects that reduce the value experienced by users
R2.1 – Word-of-mouth acquisition (virality)	USERS (S1) ➔ Realized interactions on platform ➔ Perceived value.. ➔ Use-based intention to recommend ➔ Referrals ➔ Viral conversion rate ➔	Reinforcing – existing users' referrals convert potential user to active user
R2.2 – Spreading the interest via WoM	Mechanism is same as R2 with exception: referrals ➔ number of interested users (potential users) ➔ USERS S1 users	Reinforcing – existing users WOM creates awareness and increases size of potential users group
Same-side loops (S2)		
R5 – Growth by same side effect (S2)	USERS (S2) ➔ Benefits of same side users➔ Attractiveness of platform (for S2) ➔ Conversion rate of new users	Reinforcing – new high profile supplier increasing bargain power of suppliers
B6 – Decreasing adoption due to same side effect	USERS (S2) ➔ Harms of same side users ➔ Attractiveness of platform (for S2) ➔ Conversion rate of new users	Balancing – increasing competition between suppliers makes platform less attractive for potential users
B8 - Increasing churn	USERS (S2) ➔ Harms of same side users ➔ Side 2 attrition rate	Balancing - negative effects of increasing # of users churns of customers
B7 – Market saturation	POTENTIAL USERS (S2) ➔ Adoption rate (S2) ➔	Balancing – Depletion of potential users
Cross-side loops Drawn in figure only on one way (S2 ➔ S1), but applies on both ways		
R6 – Cross-side growth	USERS S2 ➔ Cross-side network effects ➔ Perceived value of platform (S1) ➔ Loyalty ➔ # of users (S1) ➔ attractiveness of the platform for S2 ➔ Conversion rate S2	Reinforcing - Complementary offerings
B2 – Cross-side balance	USERS (S2) ➔ Negative impact of S2.. ➔ Service quality ➔ Perceived value of platform (S1) ➔ Loyalty ➔ Number of users (S1) ➔ Attractiveness of platform (S2) ➔ Conversion rate (S2)	Balancing - Negative sides of plethora of offerings

Table 4
Causal loops related to retention.

No / name	*Flow*	*Type - example*
R3 - Retention	Perceived value of platform (S1) ➔ Loyalty ➔ Attrition rate ➔ USERS (S1) ➔ Realized interactions ➔	Reinforcing – Valuable interactions create loyalty to use platform
R10 – Boosting the use	Realized interactions on platform ➔ Perceived value ➔ Loyalty ➔ Motivation for re-use	Reinforcing – Using the platform makes it more appealing to use more
B9 – Fulfilling the needs	Realized interactions ➔ Motivation for re-use	Balancing – After fulfilling the needs, no immediate motivation to reuse
R4 – Attractiveness through brand value	Perceived value.. ➔ Collective brand value ➔ Relative attractiveness of platform ➔	Reinforcing – Individual experiences improve brand value, which improves overall attractiveness

Table 5
Causal loops related to balancing with scarce resources.

No / name	*Flow*	*Type - Example*
B3 – Burn rate (sales & marketing)	Paid customer acquisition/Paid awareness building/Retention marketing ➔ Sales and marketing costs ➔ Total costs ➔ Available financial resources ➔ Sales and marketing budget	Balancing – Sales work drains resources immediately (and is expected to bring in money later)
B4– Burn rate (operations)	Financial resources ➔Customer service & operations budget ➔ Resources per customer ➔ Service quality ➔ Perceived value.. ➔ Loyalty ➔ Attrition rate ➔ USERS (S1) ➔ User-related operational costs ➔ Total costs ➔ Similar of feedback loop balances number of users on side 2	Balancing – Manual customer work increases satisfaction of existing customers but creates spiralling costs when number of customers increase
B5 – Burn rate (development)	Development ➔ Total costs ➔ Financial resources ➔ R&D budget	Balancing – Development is limited by start-up's "runway"

(*continued on next page*)

Table 5 (*continued*)

No / name	*Flow*	*Type - Example*
R8 – Competitive advantage	Development ➔ Relative competitiveness ➔ Relative attractiveness ➔ Market-based conversion ➔ Adoption rate ➔ USERS (S1) ➔ Total revenue ➔ Financial resources ➔ R&D budget	Reinforcing – new features improving competitiveness, loyalty and spending
R9 – Loyalty increased spending	Sales and marketing budget ➔ Retention marketing ➔ Loyalty ➔ Avg. spending per customer ➔ Total revenue ➔ Financial resources	Reinforcing – Marketing content tailored for specific users increases their loyalty and spending
R11- More users more revenue	USERS (S1) ➔ Total revenue ➔Financial res. ➔Sales & marketing budget ➔ Paid customer acq. ➔ Relative attractiveness ➔ Market-based conversion ➔Adoption rate	Reinforcing - Paid customer acquisition brings in more paying users

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