The Journal of Systems and Software 96 (2014) 61–72

Contents lists available at ScienceDirect

The Journal of Systems and Software

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

Sources of value in application ecosystems

Sami Hyrynsalmi[a,*], Marko Seppänen[b], Arho Suominen[c]

[a] University of Turku, Turku School of Economics, Department of Management and Entrepreneurship, Finland
[b] Tampere University of Technology, Department of Industrial Management, Center for Innovation and Technology Research, Finland
[c] VTT Technical Research Centre of Finland, Turku, Finland

ARTICLE INFO

Article history:
Received 26 September 2013
Received in revised form 16 May 2014
Accepted 18 May 2014
Available online 29 May 2014

Keywords:
Software ecosystem
Value creation
App economy

ABSTRACT

Mobile application stores have revolutionised the dynamics of mobile ecosystems. Research on mobile application ecosystems has been significantly driven by data that is focused on the visualisation of an ecosystem's dynamics. This is a valuable step towards understanding the nature of the ecosystems, but it is limited in its explanatory power. Thus, a theory-driven approach is needed to understand the overall dynamics of such systems. This study applies a theoretical framework of value creation in e-business in the context of mobile application ecosystems, with a focus on application developers. A qualitative research strategy is employed in testing operationalisation in a sample of developers. The sample comprises 27 application developers from the three leading mobile application ecosystems. The results show that efficiency is the main source of value, products seldom create value through complementarities, and approaches towards lock-in and novelty seem to vary among application developers. The managerial and theoretical implications of such biased value creation in mobile ecosystems are considered.

1. Introduction

Mobile ecosystems have been revolutionised by mobile application stores such as Apple's App Store and Google Play. There is widespread interest in understanding the key elements of mobile application stores. Creating value and balancing variability, while retaining sufficient control (Hartmann et al., 2012) are crucial from the broad software application creation viewpoint. Recent studies have mostly been limited to data-driven exercises for describing and visualising various mobile ecosystems (see e.g. Basole and Karla, 2011, 2012; Hyrynsalmi et al., 2012a; Suh et al., 2012). Mapping and visualising changes and inter-firm relationships in these rapidly evolving marketplaces have been valuable steps towards understanding the nature of mobile ecosystems. The quick growth in both the number of applications offered in mobile application stores and the revenue generated by them, as well as success stories of individual application vendors have created hype around the new industry and resulted in the term 'app economy'. This term is currently used to describe the entire mobile business environment (Basole and Karla, 2012).

Instagram, an on-line photo- and video-sharing service, is a glorified example of an application that is free to its user, thus generating no revenue directly. Despite this, this application (the company) was acquired in April 2012 by Facebook Inc., for approximately $1 bln USD in cash and stock (Wall Street Journal, 10 April 2012). However, in addition to the small number of successful companies, there are hundreds of thousands of other application vendors committed to the marketplace. Launching an application in today's congested marketplaces is a difficult task. It is not well understood how to create value that users can appreciate adequately. In addition, appropriate metrics for assessing and managing such value creation processes to tailor an application to market needs are not known (Edison et al., 2013). Numerous mobile application ecosystem-related studies focus on either analysing an entire ecosystem or on studying an ecosystem from the orchestrator (the marketplace owner)'s viewpoint. However, there are studies from the viewpoint of an application vendor as well (see Holzer and Ondrus, 2011). Furthermore, surprisingly, we know little about the value creation mechanisms and their uses in mobile application ecosystems from an application developer's perspective.

Motivated by the number of studies describing the structure and overall dynamics of different ecosystems (e.g. Basole, 2009; Xia et al., 2010; Basole et al., 2012; Gueguen and Isckia, 2011; Kabbedijk and Jansen, 2013), our aim is to further investigate the theoretical framework of value creation in mobile ecosystems with a focus on

* Corresponding author. Tel.: +358 2 333 6439; fax: +358 2 333 8900.
E-mail addresses: sami.hyrynsalmi@utu.fi, sthyry@utu.fi (S. Hyrynsalmi), marko.seppanen@tut.fi (M. Seppänen), arho.suominen@vtt.fi (A. Suominen).

http://dx.doi.org/10.1016/j.jss.2014.05.064
0164-1212/

the application vendor's perspective. The main research question is as follows:

- What are the sources of value creation in mobile application ecosystems from an application vendor's point-of-view?

In this paper, we define a 'mobile application ecosystem' as an interconnected system comprising an ecosystem orchestrator, mobile application developers, and mobile device owners, all of whom are connected through a marketplace platform. This definition is based on previous studies of software ecosystems (see Hanssen, 2012; Manikas and Hansen, 2013; Jansen and Cusumano, 2013) and mobile ecosystems (see Basole, 2009; Gueguen and Isckia, 2011). The theoretical framework for understanding the abovementioned ecosystems stems from the value network theory (Li and Whalley, 2002) as well as from later theoretical frameworks used for analysing business ecosystems (e.g. Adner, 2012) and business models (e.g. Teece, 2010). These frameworks are essential for understanding of the dynamics of software ecosystems, such as entry barriers to a market, monetary transactions, and co-creation among actors, which are different from those applicable to traditional tangible or service markets. The complexities of mobile application ecosystems force companies to cooperate (Xia et al., 2010). Simultaneously, however, application developers seldom restrict themselves to only one ecosystem (Gueguen and Isckia, 2011). This leads to complex value-creation- and value-capture models that need to be analysed.

Value creation is a central concept in management studies (Lepak et al., 2007). Bowman and Ambrosini (2000) define value creation as the difference between use and exchange value at all levels of analysis. Mobile application ecosystems are virtual markets characterised by extended reach across various boundaries (geographical, company-related, and individual) and richness of interaction (reduced information asymmetry, one-to-one relationships, increased speed) (Zott et al., 2000). Hence, the theoretical foundation of this paper derives from the model of value creation in e-business by Amit and Zott (2001). The model is built on theories of virtual markets, value chains, Schumpeterian innovation, resource-based view of a firm, strategic networks, and transaction costs. Based on these theories, the framework creates a four-dimensional model of value creation in e-business. Thus, we consider efficiency, lock-in, complementarities, and novelty as the key value drivers of value creation in mobile application ecosystems. Our results show that differences in value creation can be identified with this approach, especially, with an emphasis on efficient value creation. Amit and Zott (2001)'s framework—in addition its explanation power—offers a practical method to assess value creation in the mobile application ecosystems.

The remainder of this paper is structured as follows. The next section introduces the theoretical background. The section that follows describes the research method employed in this study. The sections thereafter summarise the findings and discuss their implications for research and practice. The final section concludes the paper and suggests avenues for further research.

2. Theoretical background

In this section, we define key concepts and present a brief overview of mobile and software ecosystems in general. We then narrow the focus to value drivers.

2.1. Mobile and software ecosystems

The term 'mobile ecosystem' refers to a complex network of manufacturing companies and service providers that together produce an abundance of different products and services for modern mobile phone and smart device users. This definition stems from the concept of a value network—a complex and interconnected web of direct and indirect ties among a group of actors to create or co-create value for customers through the development of products and services (Basole and Rouse, 2008; Blau et al., 2009). The definition of mobile ecosystem also stems from the concept of a business ecosystem, which is seen as a value network including customers, suppliers, competitors, and other stakeholders who "coevolve their capabilities and roles, and tend to align themselves with the directions set by one or more central companies" (Moore, 1996). Business ecosystems can be understood as a network of specialised and complementary opportunity niches as well (Muegge, 2013). The key advantage of this approach is the inclusion of customers into a business ecosystem, which provides new opportunities for explaining value co-creation that were difficult to tackle using the value network approach (Adner, 2012; Mäkinen and Dedehayir, 2013). With regard to mobile-specific business ecosystems, Xia et al. (2010) argued that the current mobile ecosystems are huge networks with complex relationships among the actors. Furthermore, owing to the complexities of these ecosystems, the participants are required to collaborate.

Basole (2009) characterised this complex network by identifying 14 different industry segments in the entire mobile ecosystem, from mobile network operators and application vendors to cable providers and device manufactures. Some of the identified segments such as gaming providers are, at the time of publication, emerging, whereas others segments are seen as being incumbent. Gueguen and Isckia (2011)'s study shows that regardless of the number of segments used to describe a mobile ecosystem, the borders of mobile ecosystems are unclear and that the actors in a specific ecosystem often participate in multiple ecosystems.

Basole and Karla (2011) studied the evolution of inter-firm relationship dynamics via visualisation of 2006–2010 market data. They argue that the industry has undergone rapid transformation in value creation and delivery owing to the introduction of application stores. In addition, Basole and Karla (2011) note that the popularity of mobile applications and application stores has led to creation of the term 'app economy' for describing this phenomenon. They show how value creation has been transformed into an app economy and how the roles of mobile network operators and content aggregators have diminished because of that change. Peppard and Rylander (2006) even argue that mobile network operators are most likely not able to offer or not even interested in offering a broad spectrum of content that interests consumers. Furthermore, they argue that those who understand and are able to exploit sources of value in the new ecosystems will successful.

Another conceptualisation related to the App economy is the 'software ecosystem', which consists of software vendors, and service and software suppliers. Jansen et al. (2009) define a software ecosystem as "a set of businesses functioning as a unit and interacting with a shared market for software and services, together with the relationships among them. The relationships are frequently underpinned by a common technological platform or market and operate through the exchange of information, resources, and artefacts". Mobile application stores are regularly used as an example of a software ecosystem (see e.g. Bosch, 2009; Burkard et al., 2012; Jansen et al., 2009; Weiblen et al., 2012).

The concepts of 'mobile ecosystem' and 'software ecosystem' have been derived from the concept of 'business ecosystem'. However, mobile ecosystems and software ecosystems mainly differ because of their different emphasis on domain-specific features. The concept of a mobile ecosystem focuses on activities needed to produce a working mobile device with electronic components, content, and services, whereas a software ecosystem focuses on organisations with similar needs or focus areas, for example, companies working on the same software platform.

A software ecosystem emerges inside a mobile ecosystem, and it contains some of the mobile ecosystem's actors such as the ecosystem orchestrator. However, a few of the actors present in mobile ecosystems are not present in mobile application ecosystems. For example, a silicon vendor does not play any role in a mobile application ecosystem, but the same vendor is a very important player in a mobile ecosystem. Given our focus on application vendors, the concept of mobile ecosystem is too broad for our use. In addition, the definition of software ecosystem implies that each of its actors survive and thrive through the survival of the entire ecosystem. This, according to the definition by Jansen et al. (2009), should manifest as an exchange of information, resources, and artefacts among software producers in the ecosystem. However, companies in mobile application stores seem to interact only with the ecosystem orchestrator and with their customers, and not with other similar ecosystem players.

2.2. Value drivers in mobile application ecosystems

Mobile application ecosystems have been studied from different perspectives, and the importance of value creation has been noted (see e.g. Basole and Karla, 2012; Peppard and Rylander, 2006). The concept of this ecosystem is even characterised by actors benefiting from the value created (to the end-user) in the system (Hartmann et al., 2012). A considerable amount of research has been published that attempts to clarify the sources of value in mobile commerce and mobile applications (see e.g. Kleijnen et al., 2007; Kim et al., 2007; de Reuver and Haaker, 2009; Gummerus and Pihlström, 2011). However, these studies have been on explaining the perceived value from the consumers' perspective and in the service context. In this study, we limit our level of analysis to applications and consider them as products, not services.

In this study, we employ the framework of Amit and Zott (2001) to identify various sources of value in mobile application ecosystems. The framework has been cited widely in extant literature (more than 2800 citations by March 2014 according to Google Scholar) and used in many explorative studies (e.g. del Águila-Obra et al., 2007). Amit and Zott (2001) investigated the theoretical foundations of value creation in e-business, and through cross-case analyses, they identified common value creation patterns. The framework was developed based on these patterns, thus integrating strategy and entrepreneurship perspectives. They argued that value is created through the manner in which transactions are enabled, and suggested that the four unique, interdependent factors governing value creation are (hereafter, value drivers): efficiency, complementarities, lock-in, and novelty. These major value drivers and their characteristics are shown in Fig. 1.

'Efficiency' suggests that transaction efficiency increases when the cost (broadly defined) per transaction decreases. Several mechanisms exist to reduce costs, for instance, decreasing information asymmetry or search costs for buyers. 'Complementarity' advantages emerge in scenarios where bundling multiple goods provides greater value than offering the same set of the goods separately. In 'lock-in', customers are motivated to engage in repeat transactions and are willing to continue their relationship with the firm. Reaching a lock-in situation may result in increasing the willingness of customers to pay more, while lowering the opportunity costs to firms. 'Novelty' refers to new product and service innovation, as well as the introduction of new methods of conducting and organising business. This source of value has several linkages with the other three sources, as described by Amit and Zott (2001, p. 508). Moreover, they argue that the interdependence of value drivers can enhance the effectiveness of any single value driver.

3. Data and method

In this section, we explain the research procedures employed, starting with our research strategy and data collection method. Then, we describe our sample selection process and describe the operationalisation of value creation measures.

3.1. Research strategy

Owing to limited knowledge about how developers actually attempt to create value in application ecosystems, we chose to adopt a qualitative research approach (Yin, 1994). To start with, we reviewed existing literature on value creation in mobile ecosystems, particularly in application ecosystems. Based on Basole and Karla (2011)'s assessment of mobile ecosystem structures and Hyrynsalmi et al. (2012b)'s measurement, we assumed that a relatively low number of top applications account for the majority of all downloads. Thus, we focused on how these top applications create

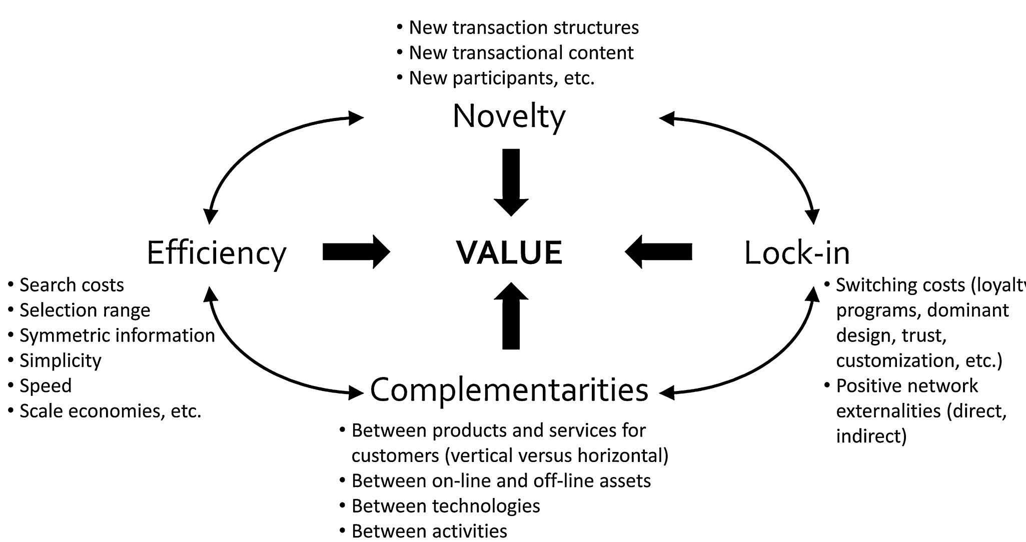

Fig. 1. Sources of value creation in e-business.

Adapted from Amit and Zott (2001).

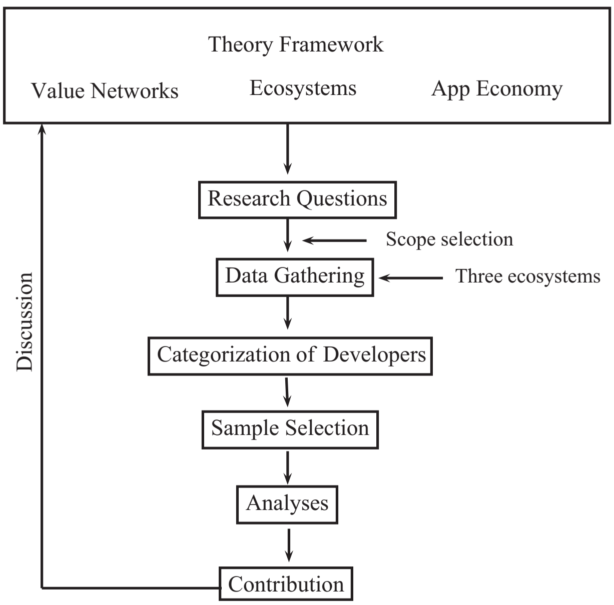

Fig. 2. Research procedure of this study.

value in their respective ecosystems. Furthermore, we focused on application developers as key actors who create value in the mobile ecosystem, and specifically, on multi-homing developers who publish their applications in more than one of the three ecosystems considered herein. This selection allowed us to focus on a limited number of key actors and on the sources of value in these contexts. Fig. 2 shows a schematic illustration of the research procedure.

To cover various value creation strategies extensively, we constructed a decision tree (Fig. 3). The selection process attempted to include different types of businesses and value creation strategies that may be present or employed in the ecosystems. The decision tree contains six levels and nine categories.

In the first level, the developers are divided into organisations and individuals. In the second level, we distribute organisations into not-for-profit and for-profit entities. In the third level, we group them into Information and communications technology (ICT) companies and non-ICT companies. In the fourth level, ICT companies are separated into content producers, application distributors, and ecosystem orchestrators, i.e. ecosystem hub firms. The fifth level divides content producers into game companies and other application- and service providers. Finally, the last level contains content creation companies and divides them into two groups: those focused on application development for mobile and similar platforms, and those that produce software for a wide range of platforms and operating systems. To conclude, the nine groups are (1) individual developers, (2) non-profit organisations, (3) non-ICT application publishers, (4) ecosystem orchestrators, (5) content publishers, (6) mobile game developers, (7) mobile utility application developers, (8) multiplatform software developers, and (9) multiplatform game developers. We employed this developer classification approach over other methods such as the value-capturing method (e.g. free, paid, in-app payment, etc.) because the selected approach stresses on the types of developers.

3.2. Initial data collection

We used the top application listings from the Apple, Google, and Microsoft ecosystems to identify the key application vendors, i.e. the best-performing application vendors. For the Apple and Google ecosystems, we gathered the top 100 applications from their free applications, paid applications, and largest grossing application lists. The list of largest grossing applications sorts applications based on the revenues obtained from direct application sales and in-application purchases by consumers. The list of top-grossing applications was not available for Microsoft's ecosystem; thus, we were forced to use only two lists: the top 100 paid applications and the top 100 free applications. Overall, 622 unique applications were selected for the analysis from a sample of 800. The lists were created in January 2013.

Next, we listed the companies that developed these622 unique applications and removed duplicate developer entries from the list. The resulting list contained 177 application developers from Apple's ecosystem, 194 from Google's ecosystem, and 152 from Microsoft's ecosystem. When the lists were combined and duplicates were removed again, we had a list of 429 application developers who produce the best performing applications across the three major mobile ecosystems.

The decision tree was used for categorising the 429 application developers from the three major mobile ecosystems. We went through the created list and used the developers' homepages, web search engines, and information about the ecosystems' marketplaces to make decisions and choose representatives for a category at different stages of the tree. Regarding the unsolved or vague cases, the authors discussed each case before the unanimous decision how to solve the case was made. The initial sample comprised dozens of developers that were selected randomly from these 429 developers. The authors crosschecked to assess whether each randomly selected company represented its particular category.

3.3. Final sample

For sample selection, we followed the guidelines of Miles and Huberman (1994) and Curtis et al. (2000). For the final sample selection, we considered the potential for generating rich information and checked whether we can produce reasonable explanations based on the applications we selected. Although all developers are active in the digital domain, there are limits to the amount of information available. Specifically, in the case of individual developers, there is a lack of data. This ultimately led us to exclude several well-known developers. Furthermore, ecosystems are highly dynamic in nature not only in terms of the number of entries into the market but also in terms of the number of exits. Thus, we selected cases

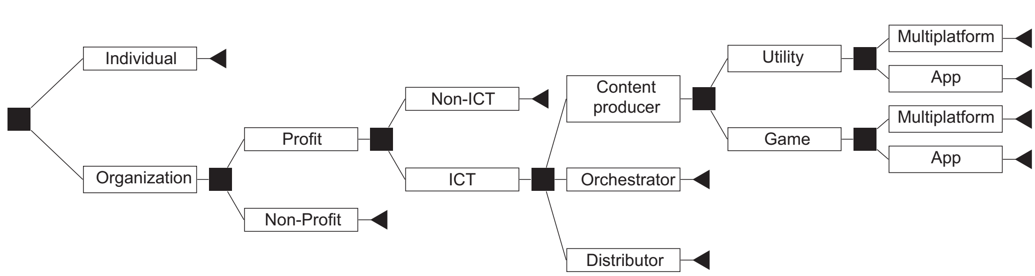

Fig. 3. Categorisation of application vendors. The triangles indicate the nine categories.

that have existed in the ecosystems for a significant period. To summarise, we used the following criteria when selecting the case study companies:

1. There is rich information available about the developer. We evaluated the information available from the developer's website, news feeds (i.e. Reuters, Google News, Yahoo News), etc.
2. The developer is established in the ecosystem or, in the case of non-software developers, in their respective fields.
3. In general, the developer should have published more than one application. This, however, excludes cases where the application is a portal for the actual service or the product provided by the developer.

The categorised developers were studied by two of the authors with a focus on the above criteria. The authors selected possible sample cases individually for each of the identified vendor categories and wrote a short justification for each selection. Through several iterative discussions, the process resulted in the set of developers listed in Table 1. The justifications for their selections, too, are presented in the table. Among the non-profit organisations, there was lack of proper candidates as well as of suitable information. Therefore, we were forced to select one non-profit organisation outside of the list of 429 vendors that was used in this study. We selected Wikimedia Foundation owing to the availability of rich information and the popularity of its applications across mobile application ecosystems.

Table 1 shows different monetisation and publishing strategies. For example, paid download refers to cases where a consumer pays for a license to use the application before downloading it. Furthermore, application vendors employ a wide variety of monetisation models in their applications, including, typically, feature-limited versions of some of their applications. Monetisation is significant when understanding value creation because by looking at how a developer creates a value-capturing mechanism, we can holistically evaluate the value creation process. In this paper, we studied the mobile ecosystem orchestrators only in the application providers' role, i.e. we excluded these companies' other interests and actions within the ecosystems. Furthermore, mobile application ecosystem orchestrators' motives, governance strategies, and value-capturing methods have been discussed in several studies (see, e.g. Cuadrado and Dueñas, 2012; Kenney and Pon, 2011; Hyrynsalmi et al., 2012a).

3.4. Operationalisation

We used the widely cited framework by Amit and Zott (2001) to operationalise the sources of value in this domain. Even though there are some similar works in different domains (e.g. Lee et al., 2010; Mladenow et al., 2012), we carefully reconsidered each value source, its items, and operationalisation for this context.

We established clear metrics based on the specific characteristics of mobile application ecosystems. Amit and Zott (2001) suggested four value drivers: efficiency, lock-in, novelty, and complementarity. We divided the major value drivers into smaller activities and formatted them as statements by following the guidelines presented in Amit and Zott (2001) and Zott and Amit (2007) (see Table 2). Two researchers studied each company and answered the statements with a scale from 'not found', 'no support', 'partly supported in use', to 'use supported'. After finalising the evaluations, the authors met and discussed the differences in their results. In the case of any disagreement, the data were studied again and discussed until consensus was reached (see Appendix for detailed description).

We focused on the individual application vendors and not on the overall value creation in mobile application ecosystems, which has clear consequences. For example, from an ecosystem orchestrator's viewpoint, all applications bind a customer more tightly to an ecosystem and thus strengthen the ecosystem lock-in effect. That is, every application and in-application feature that a customer buys tightens the lock-in effect of the ecosystem because, most likely, a customer would not want to buy the same application again from another application store. However, from the viewpoint of an application vendor, the ecosystem lock-in is not that relevant—the number of customers and the level of competition increase simultaneously. In the next section, we summarise our findings.

4. Findings

Table 3 summarises our findings. The table shows for each main value driver (efficiency, lock-in, complementary, novelty) our measure (operationalised item) and the extent to which that particular item can be found in the case applications.

To consider whether the nine categories shown in Fig. 3 differ from each other with statistical significance, we applied the Kruskal–Wallis test.[1] It was found that only for two items were there statistically significant differences among the categories (in terms of lock-in, non-profit organisations, non-ICT application developers, orchestrators; in terms of novelty, mobile application developers and game developers and publishers differ from other categories). These differences seem to reflect the nature of operations in these categories, and thus, we interpret that these differences actually support the assumption that the categorisation captures some of the diversity of the initial sample. We divided the findings into four parts according to the framework used in this study. We first discuss value creation due to efficiency and complementarities (major value drivers) before discussing lock-in and novelty in a mobile application ecosystem from the software vendor's viewpoint. In the following discussion, we raise a few example cases pertaining to each value driver.

4.1. Efficiency

For the major value driver efficiency, Amit and Zott (2001) identified several minor value sources. For example, value can be added from the customer viewpoint by decreasing transaction costs (transaction efficiency), offering up-to-date information for reducing search costs, and generating economies of scale. In summarising their theoretical assumptions and empirical findings, Amit and Zott (2001) stated that transaction efficiency is a 'primary value driver' in e-business.

Similarly, in this domain, transaction efficiency seems to be an important value driver for the studied application vendors. In practice, the ecosystem orchestrator controls the transaction infrastructure in their ecosystem. Transactions outside of the ecosystem often are not recommended because they limit the revenue gathered by the orchestrators.

Orchestrators strive to create efficient transaction processes that they themselves control. These are in the form of direct fees on the download of an application or through various in-application payment methods. For example, most game- and other software developers rely on these transaction methods established by the orchestrator. However, there are more elaborate business models that work outside the orchestrator-created infrastructure. For instance, MeetME uses its own 'lunch money' concept for payments inside the application, while WhatsApp is, after a long trial period, a subscription-based service in certain countries. However, these

[1] The Kruskal–Wallis test is a non-parametric method of testing whether samples are significantly different,and it is specifically suitable for situations where the samples are not normally distributed or the samplesize is small.

Table 1
Selection and justification of mobile application software vendors.

	Vendor	Information and justification to select	Monetisation[a]
Individual developers	Developer of Tiny Wings	A developer of a popular game; due the media coverage, there were enough information available. Due to privacy issues, we do not use their real name in this study.	P
	Hexage	A small game company that has previously published game with the developer's name. Produced a few popular games.	IA, FL, P
	Developer of Logos Quiz	The developer has published only for one ecosystem a dozen games. Publishes with his own name.	A, FL
Mobile App Developer	WhatsApp	Pure mobile developer, with rich information available. One of the top-grossing applications. Focused on one chat application.	S, FL
	MeetME, Inc.	A special case of mobile developers – where the mobile application is strongly connected to an existing web-based service. Rich information due to being a stock listed company. Focused on one dating application.	S, IA
	Azumio Inc	Health applications developer which has more than 20 million downloads.	P, FL
Mobile game developer	Gameloft S.A.	A leading mobile gaming company established in 1999. Rich information due to being a listed company. Several products available.	FL,P, A, IA
	Auxbrain, Inc.	Pure game developer with one successful game.	FL, IA, A
	Fingersoft	Pure game developer with a small number of successful games. Recently started to publish other developers' games for mobile ecosystems.	A, P, IA
Multiplatform game developer	Rockstar Games	A subsidiary of Take-Two Interactive, focused on computer and video game development. Significant success in console and PC platforms.	P, F, IA
	11 bit studios	Long experience in game development now focusing on mobile games.	P,IA
	Ubisoft	Large multinational game development company with significant success in multiple platforms. Rich information due to being a stock listed company.	P, IA, A SP
Multiplatform software developer	Autodesk Inc.	Software company focusing on the development of 3D design software. Founded 1982, since then focused heavily on CAD and media and entertainment software. Company is traded in NASDAQ.	P, S, FL, IA
	Endomondo	Sports tracking software developer with a mobile application. Established in 2007.	P, S, FL
	Facebook	Publicly listed social networking site operator using multiple platforms.	F, A
Content publisher	Chillingo	Chillingo is a subsidiary of Electronic Arts. A leading publisher of games in iOS and operates also in other platforms.	P, FL, A, IA
	6waves	A leading publisher of independent games on social networks and mobile platforms.	P, FL, A, IA
	Mobage, Inc.	Game publisher in iOS and Android.	P, FL, A, IA
Non-ICT application publisher	Walgreen Co.	Largest drug retail chain in the United States. Founded in 1901, the company is stock listed, with rich information readily available.	SP, F
	Bank of America	One of the largest financial sector companies in the United States. The company is stock listed, with rich information readily available.	SP, F
	Weight Watchers International, Inc.	The company offers products and services to assist weight loss and maintenance. Founded in 1963, the company is stock listed, with rich information readily available.	SP, F
Non-profit	Lifechurch.tv	Selection was limited by the amount of non-profit organisations availability, thus this was considered as a deciding factor. Lifechurch is a large evangelical church with an established mobile presence.	N, F
	ZXing Team	Open-source, multi-format 1D/2D barcode image processing library.	N, F
	Wikipedia Foundation	The organisation itself is well-known non-profit foundation and its official Android application has been installed million times.	N, F, D
Orchestrator	Apple Inc.	Company is an ecosystem orchestrator. The company is stock listed, with rich information readily available.	F, P, IA
	Google, Inc.	Company is an ecosystem orchestrator. The company is stock listed, with rich information readily available.	F
	Microsoft Corporation	Company is an ecosystem orchestrator. The company is stock listed, with rich information readily available.	F, P, IA

[a] Abbreviations: A, advertisements; S, subscription; IA, in-application purchase; F, free; FL, feature limited (e.g. free trial); SP, support core offering; N, not-for-profit; P, paid download; D, donation.

Table 2
Source of value creation and item-level operationalization.

Source	Item	Operationalization
Efficiency	Search cost	Search costs are diminished by supporting multiple platforms/devices Search costs are diminished by clearly defining all of the features and functionalities of the product in the ecosystem marketplace.
	Selection range	Vendor offers a range of differentiated products to serve the specific needs of the customer
	Symmetric information	Vendor provides up-to-data and comprehensive information on products
	Simplicity	Transactions are simple from the user's point of view
Lock-in	Loyalty programs	Vendor rewards the repeat use or purchase from the ecosystem
	Trust	Vendor creates value to the consumer by establishing added safety and security guidelines
	Customization	Products can be customised by the consumer
	Contact point	Vendor offers a contact point for the user to communicate with the developer
	Virtual communities	Vendor has created a virtual community to add value for the end user
	Network effect	Vendor creates value to the user by actively increasing the number of users
Complementary	Between products and services for customers	A variety of features, products and services are bundled to create value The consumer is provided a complete service solution?
	Between on-line and off-line assets	Value is created through a combination of online and offline capabilities
	Between technologies	Value is created by combining capabilities of multiple technologies (for example combining software applications and RFID technology for geolocation).
	Between activities	Consumer is provided an access to products and services that are complementary to the primary product or service of interest sold in the ecosystem
Novelty	New content	Vendor provides the consumer with value through a new to the world product, service or information
	New features	Vendor provides the consumer with value through new features or processes in existing product, services of information
	Re-structuring processes and transactions	Vendor has restructured an existing process or transaction offered previously in the market place, thus creating value to the consumer
	Migrating	Vendor has provided an existing product or service through the mobile medium for the first time, thus creating value to the user

transactions are not well explained to the consumer, and at least with WhatsApp, information about the cost of long-term application use is unclear. Moreover, at times, the provided explanations create confusion, thus slowing the process and resulting in inefficiency. Finally, Apple has actively removed applications that use transaction methods other than theirs for in-application payments.

More important than transaction efficiency is the search cost associated with the product. Owing to the enormous number of applications offered in the markets (see e.g. Hyrynsalmi et al., 2012b), the search cost is one of the most significant efficiency factors in the mobile application ecosystem. We divided the search cost analysis into two dimensions: offering services across several mobile platforms and defining product features and functionalities through a marketplace.

Bank of America, Facebook, Endomondo, Gameloft, WhatsApp, and Wikipedia are distinguished by their strategy of diminishing customer search cost by providing access from multiple mobile platforms and by even offering their services through platforms other than the big three mobile application ecosystems. As an example, Wikipedia Foundation has published official applications for the big three ecosystems and for the BlackBerry World ecosystem as well. In addition, similar unofficial thin clients to the encyclopaedia are available for most smart devices. Whereas other applications in the sample work with either a more restricted number of ecosystems or only on one mobile application ecosystem, thus increasing search cost. Interestingly, as a game publisher, Chillingo, too, has adopted a narrower approach of publishing almost exclusively for one ecosystem. Among the ecosystem orchestrators, Apple publishes only for their own ecosystems, while Google and Microsoft offer their products to consumers of other ecosystems as well.

The actual search cost for a specific utility is fairly low in mobile application ecosystems because there are many competing product offerings. For example, a consumer can find several flashlight and calendar applications in each of the marketplaces. Only products with a specific network effect are amongst the possible proprietary applications that are sought after, such as the photo sharing application Instagram. Consequently, a significant amount of the overall number of applications can be easily substituted with competing offerings because rather elementary programming skills are needed to replicate the original ideas.

For the second dimension of search cost, information asymmetry between the customer and developer are reduced through the orchestrator-created format of delivering information to and from the marketplace. This is manifested through an active consumer feedback system that developers are forced to adopt. This adds electronic word-of-mouth (eWOM) to the product information provided by the developer, thus giving potential customers an insight into the product offering.

Other approaches that further diminish possible information insufficiencies vary. Companies such as Autodesk and Endomondo have launched their products through the mobile application ecosystem and have extended the information available in the marketplace by making video tutorials available on the company website. This is very likely driven by product complexity, as the developer of Tiny Wings, a simple two-dimensional game, has made little effort to provide comprehensive information about their product.

In mobile application ecosystems, another means of offering comprehensive information is by giving free access to the product, either with a free-to-try approach or by using a business model that grants access to the software for free. In the sample, the majority of developers offer some means of accessing and testing the product for free. Game developers and publishers such as 11 bit Studios, Rockstar Games, and the developer of Tiny Wings are the only ones whose core products are not available for free. This suggests that being free is a significant source of efficiency; in other words, the application can be easily tested before monetary investment is needed, and the availability of a free version for testing adds value from the consumer viewpoint.

Table 3
Summary of key findings. The table shows the frequencies of different options of the value drivers ($N = 27$). The cells' background colour illustrates the utilisation rate of different options.

Source	Operationalised item for each value source	Not applicable	Not found	No support	Partly supported in use	Use supported	Sig.
Efficiency	Search costs are diminished by supporting multiple platforms/devices	0	3	7	11	6	0.271
	Search costs are diminished by defining product features and functionality through the ecosystem	0	1	8	12	6	0.44
	Vendor offers a range of differentiated products to serve the specific needs of the customer	0	8	6	5	8	0.446
	Vendor provides up-to-data and comprehensive information on products	0	1	15	7	4	0.11
	Transactions are simple from the user's point of view	10	2	3	2	10	0.087
Lock-In	Vendor rewards the repeat use or purchase from the ecosystem	0	22	0	5	0	1
	Vendor creates value to the consumer by establishing added safety and security guidelines	0	6	16	3	2	0.221
	Products can be customized by the consumer	3	20	2	2	0	0.392
	Vendor offers a contact point for the user to communicate with the developer	0	1	4	15	7	0.118
	Vendor has created a virtual community to add value for the end user	0	9	7	5	6	0.041*
	Vendor creates value to the user by actively increasing the number of users	0	17	6	1	3	0.208
Complementary	A variety of features, products and services are bundled to create value	3	13	1	9	1	0.155
	The consumer is provided a complete service solution?	15	1	0	8	3	0.421
	Value is created through a combination of online and offline capabilities	3	14	2	4	4	0.134
	Value is created by combining capabilities of multiple technologies	0	17	3	4	2	0.217
	Consumer is provided an access to products and services that are complementary to the primary product or service of interest sold in the ecosystem	0	21	0	4	2	0.717
Novelty	Vendor provides the consumer with value through a new to the world product, service or information	0	7	9	10	1	0.165
	Vendor provides the consumer with value through new features or processes in existing product, services of information	0	13	1	12	1	0.123
	Vendor has restructured an existing process or transaction offered previously in the market place, thus creating value to the consumer	0	19	4	4	0	0.136
	Vendor has provided an existing product or service through the mobile medium for the first time, thus creating value to the user	0	3	12	9	3	0.007*

* Statistically significant at 0.05 level with Kruskal-Wallis test of independent samples.

* Statistically significant at 0.05 level with Kruskal–Wallis test of independent samples.

4.2. Complementarities

Amit and Zott (2001) argue that complementarities are a significant dimension of e-business value creation. An e-business provider can, for example, offer value to the customer through vertical (e.g. after sales services) or horizontal complementarities (e.g. one-stop shopping) and by different technologies, offering online as well as offline assets (Amit and Zott, 2001). However, our sample suggests that it is one of the least used sources of value creation from the application vendor's viewpoint. Amit and Zott (2001) also argue that complementarities are visible in the e-business domain with complementing online and offline assets, bundled product offerings, or complementary goods and processes.

A case in point is game developers, who rarely leverage complementary assets. Even the developers whose business logic is focused mainly on producing games for a number of technological platforms—ranging from the Web to consoles and mobile devices—offer sparsely complementary products or services. Game products offered in mobile application ecosystems are standalone products that leverage a successful brand offered in other platforms, but use nothing to create any complementary value for the user. Ubisoft is an exception because it has complementary applications for two of its flagship console games (the applications show, e.g. an interactive game map and statistics). While Microsoft has an application that helps console game users by showing the game map, the company has announced that it will stop the support for this application.

Similarly, the studied applications rarely combine online and offline features. Autodesk offers an application that can be used at building sites to view schemas, but, at the time of conducting this study, this application required an Internet connection to download models, thus reducing its usability at building sites.

While complementarities are sparsely used by the application developers included in the sample, there are a few clear exceptions.

For example, Endomondo has complemented several technologies because it supports a variety of heart rate monitors that are used with GPS tracking. Furthermore, Azumio has combined several self-help e-health features from coffee intake and sleep-cycle monitoring to GPS tracking of running data into one application to arrive at a more complete service solution. Similarly, Walgreens uses a number of complementary value-creation methods. They bundle their core business pharmacy and supporting businesses such as photo printing into a complementary system, wherein ICT and other technologies are leveraged to create value. Walgreens offers a complete service solution, and using its application, a user can submit refill orders for pharmacy products and use photo-printing services via the same application.

4.3. Lock-in

As argued by Amit and Zott (2001), the lock-in value driver can be approached from several different avenues. For example, loyalty programmes, trust created through safety and security, customer service through contact points, customisation, personalisation, and the network effect can be used to add value to the customer. Starting from the traditional approach, none of the case study companies, except Walgreens and Ubisoft, used loyalty programmes. This fact clearly differentiates the case study application vendors in this study from most e-commerce firms considered in Amit and Zott's (2001) study, such as Barnersandnobles.com. This suggests that lock-in is created in some other way than the model established in a traditional consumer sales loyalty programme. The only exceptions are Walgreens, where the application itself is a part of the reward programme, and Ubisoft, whose programme allows a user to gather points by playing the company's games.

A few of the studied companies actively build buyer–seller trust by creating added safety and security guidelines into the product offering. For example, Bank of America has included a detailed description of the security features used in the application. However, the majority of the companies only offered legal statements of the privacy policy. Furthermore, for several organisations, we could not find even that documentation.

Although we might understand that safety and security are more of a necessity for online transactions and banking applications, our understanding should be broadened to include the safety of the actual product, irrespective of the type of application. For example, F-Secure warned users about safety practices in the Android ecosystem and noted that several fake malware applications of one of the most successful mobile game series are available in the Google Play marketplace. In the light of this, it would be reasonable to assume that creating guidelines and security features a priori would be in the developers' interest.

This was exemplified by WhatsApp, Inc., which faced controversy because its application was downloading users' contact information to company servers without clearly explaining this to the customers. This action was found to be illegal in several countries. However, once they were forced to implement safety and security measures, WhatsApp, too, created value for users in the context of the theoretical model. MeetMe and Facebook can also be used as examples of developers using security and safety guidelines for their service. This is of course a common practice in the social networking application domain, where users are well aware of privacy issues and developers are required to act proactively on said issues. MeetME and Facebook have achieved this by implementing clear safety and security practices as well as by participating in volunteer activities and educating users to be aware of possible risks. Another approach to the same issue is that adopted by the game publisher Chillingo, which tries to achieve a brand status. Chillingo describes and brands itself as a trustworthy, high-quality game publisher in mobile application ecosystems, publishing only safe products such as the award-winning games Angry Birds and Cut the Rope.

In addition to security and safety features, an e-business company can create lock-in through communication with the consumers. Most of the studied software vendors offer several contact points such as Facebook pages, Twitter accounts, and blogs through which customers can contact the developer. One of the exceptions was Auxbrain, which has published only an email address that customers can write to if they have any questions.

The communication level between consumers and application vendors varied widely. On the one hand, the developer of Tiny Wings has thousands of followers on Twitter and a few thousand fans on Facebook, although the company's interaction with its followers has been more of a monologue from the company's side as opposed to a dialogue with the followers. Similarly, Weight Watchers sends many messages on a wide variety of topics, but the communication seems to originate only from the company to the consumers. On the other hand, for instance, Hexage actively answers questions in social media. WhatsApp Inc. and Endomondo have even had active discussions with their users on Twitter.

From the case study companies, Rockstar, Autodesk, and Ubisoft have built their own virtual communities around the products they sell on the Internet. Similarly, Endomondo has created a kind of social media service around their product. The enabling of community creation through social media outlets or developer-authored virtual forums is the preferred method of lock-in, with almost all of the sample developers offering a clear contact point, most of which are through social media sites, and several of them offering virtual communities.

Amit and Zott (2001) also discussed how customisation and personalisation can be used to create a lock-in effect. However, the companies included in the sample offer these services rather infrequently. For example, WhatsApp allows users to customise the application by changing the background; however, even this type of personalisation services is rare in our application sample. In addition, game providers offer additional features for games through in-application purchases. Hexage, for example, sells virtual items that can be used to change the gaming experience and Auxbrain offers players the option to unlock assets in game faster. Furthermore, it should be noted that the ecosystem orchestrators use a person's past installation information when offering them suggestions about alternatives or new applications. Again, the fairly appealing method of creating lock-in seems to be seldom used in mobile application ecosystems by application vendors.

The direct network effect, discussed in the network theory by Katz and Shapiro (1985), is obvious in massive multiplayer online games. For example, Gameloft and Chillingo offer games that allow a consumer to play the game online against other gamers. Similarly, Facebook, MeetMe, and WhatsApp are heavily based on the direct network effect.

4.4. Novelty

Amit and Zott (2001) argue that because of their virtual nature, e-businesses can create value by innovating methods of doing business as well as by providing new methods of production and distribution. Although the mobile application store concept itself offers high novelty value, the majority of the case study application vendors in our sample have not revolutionised their businesses.

However, an exception is Walgreens, which has developed a novel application that offers a large variety of services ranging from refilling prescriptions by Rx labels and medication reminders to ordering photo prints. According to Walgreen (2012), the adoption rate of their mobile application increased by 500% in 2011.

Creating a new unique offering such as Walgreens's service for users is challenging. Most of the mobile games studied replicated well-known games or game mechanics from other platforms. While evaluating the novelty of electronic games is hard, most of the applications produced by the case study gaming companies can be seen easily as replications of old game mechanisms with only a little new to offer. For example, in the sample, there are several different Tower defence variants by, e.g. 11 bit studios, Chillingo, Gameloft, Hexage, and Mobage. Similarly, most features offered by the utility applications are available, in one form or another, for feature phones.

WhatsApp repackages and offers the basic functionality of SMS in a new skin. Furthermore, we identified five different short message services in the top Android applications of the set we studied. Although, we should note that the evolution of the telecommunication industry (see e.g. West and Mace, 2010) has been an enabler of new processes, such as the application offered by WhatsApp, which uses fixed-cost mobile data to offer the SMS service at no additional cost. Such offers create value for the users through cost-reducing back-end process changes.

Autodesk offers several mobile applications for Google and Apple's ecosystems, and their applications allow a professional designer to view design files in the field with a smartphone or tablet computer. The design files are stored in the cloud, and the applications allow a user to communicate any changes to the designer instantly through the cloud service. Thus, the new service allows for restructuring of the traditional workflow pattern. Traditional business-to-business companies, too, have evolved to offer consumer products by creating low-cost versions of the full desktop versions of their programmes in the ecosystems. This can be seen as a new-to-the-market approach—transforming existing products for a new market segment.

Finally, as application vendors, the ecosystem orchestrators themselves have been open-minded and have offered various new types of products. For example, Google offers Google Goggles, an application that allows consumers to search by taking pictures, and Apple offers a wide range of applications from GarageBand to find my iPhone.

5. Discussion

Because this study has emphasised the application developers' and firms' perspectives, we assume that these actors would be interested in building some long-term competitiveness into their offerings (and ultimately into the firms themselves). However, long-term competitiveness depends on whether the firm manages to build a strong position in "specialised complementary assets and is capable of reconfiguring them over time in line with changes in the market environment" (Desyllas and Sako, 2013, p. 101). In value-creation activities, the firm's success in capitalising its assets becomes visible. Therefore, our main notion is that firms seem to adopt rather mixed approaches to the different value drivers, and several dimensions exist that provide potential for further improvement in the theoretical and practical senses.

Our results show that efficiency is the main value driver that application developers use in their value creation, and depending on the category, the drivers lock-in and novelty yield mixed results. Complementarities had a small value driver impact from the software vendor viewpoint. The lack of complementary value creation methods is notable, suggesting that application products mostly rely on the 'standalone' value driver. This lack of complementary value creation, especially among non-gaming developers, suggests a more general mode of operation. The developers seem to rely heavily on the utility of a single offering, even when they offer multiple products, to be able to fulfil the value expectations of the user. The notable exception is Walgreens, where the role of application is complementary to the company's core business. Several products such as social media services and cloud-based applications exist in mobile application ecosystems to create complementary value for the respective companies' main offerings. These applications work as thin clients—another frontend for data stored elsewhere—leading to the main value driver created by the company's product. An example of this type of application is Facebook. Another reason for the low focus on complementarity could be the isolation of application ecosystems due to technical reasons such as lack of application interoperability across various mobile operating systems.

Lock-in is rarely used for value creation. While most of the case study subjects offer multiple contact points, only a few of them have created virtual communities for their users. However, in mobile application ecosystems, there is an abundance of applications offered and new competitors can easily join the marketplace owing to the low entry barriers. Therefore, in the future, creating value to consumer by lock-in might be crucial for application developers. The findings suggest that with several operationalisations, we found little or no lock-in value creation. Obviously, developers do not reward purchase and repeat use, which is the model often used with services and tangibles. However, the implementation of such a reward system might be discouraged by the free to very low purchase prices of mobile applications. However, more questionable is the lack of available customisation in the product offerings, something that is often seen as a capability of intangible software products.

Novelty was sparsely found, even if there were a few exceptions such as Walgreens' application. Most applications offered by the vendors are replications of products that have been previously available in the domain. The cultural lag theory (Ogburn, 1957) may fit this context because lag occurs when one of the two correlated cultures changes before the other culture does. This causes a mismatch between the two cultures (cultures in broad sense, see Brinkman and Brinkman, 1997). Here cultural lag would mean that the fast advancements of a material culture (i.e. the technology in mobile phones and the concept of a mobile application marketplace) was not in tune with changes in the content offered for said devices. With the passage of time, the content offered for devices will improve, thus creating a new balance between cultures. This theory could explain why value-creation mechanisms are sparsely used in mobile application ecosystems.

Seemingly, we do not yet have the conceptual tools that can help firms grasp value creation mechanisms (Gambardella and McGahan, 2010). An especially popular choice is to publish an application that is free to install but includes some revenue-generating strategies (buying extra features, in-app payment for specific advancements in the game, etc.). Current financial figures show that the in-application earning logic performs well—an example of this is Supercell Oy's mobile game, Clash of Clans, which has been extremely successful in generating revenue (see e.g. Wingfield, 2012). Additionally, our results suggest that within the sample, developers have employed diverse approaches to value capturing (see Table 1) than to value creation. One of the key issues in this success is the successful inclusion of social aspects, for example multiplayer elements as well as content co-creation by users. However, the framework applied in this study does not take into account those aspects for explaining value creation through the type of applications reviewed. This was expected because the framework was designed for utility businesses instead of games.

Several issues limit this study and its findings. First, the construction of the decision tree was based on the authors' experience; different node selections would unavoidably alter the cases and lead to alternative results. The categories named in this paper were created based on the works of Basole and Karla (2012) and Hyrynsalmi et al. (2012c), but our categorisation procedure is more sophisticated than theirs are. Second, we may have selected non-representative cases for the vendor categories applications. To minimise this bias, the cases were selected carefully from several dozen candidates to include the most representative cases available. However, our initial work could help scholars in further studying this phenomenon. Third, by selecting cases with rich information available, we might be biased towards widely disseminated applications, while excluding significant but not-widely disseminated applications in niche areas. This selection bias should be considered as a limitation of the study. Fourth, the cases were studied in-depth by only two authors, which might introduce a significant bias in the results. Similarly, the authors studied the cases independently and differences were solved to reach unanimous decisions. In future work, different evaluation tactics could be used to minimise the bias of subjective evaluations. In this study, the disagreements between the authors were minor and mostly due to subjective interpretations of the data used. Fifth, the study focuses on a period when mobile application ecosystems are still developing rapidly. Thus, significant shifts could still occur in, e.g. the dynamics of this industry, business models used, or even in the relevance of the whole app economy.

6. Conclusion

This study shows that of many the theoretical value drivers only a few have been used for value creation in mobile application ecosystems. Although the importance of value creation is noticed, there is little existing research on mobile application ecosystems. The introduction of application stores has revolutionised mobile ecosystems, and increasing interest in new applications has resulted in a term to describe the phenomenon: the app economy. The focus of this paper has been on value creation among mobile application developers in three major ecosystems. We analysed 27 case study companies from a wide range of industry segments. Efficiency was found to be main value driver, whilst lock-in and novelty were found to be used only occasionally. The lack of the use of complementary offerings was remarkable. This paper presents a method for addressing value creation that can be used in further studies. Further work is needed to confirm, improve, or reject the methodology and the findings stated herein (see Uncles and Kwok, 2013). We hope that further research will reveal unused value-capturing methods in mobile application ecosystems.

Acknowledgements

The authors wish to thank Ph.D. Özgür Dedehayir for his valuable comments on the early versions of the manuscript. In addition, Sami Hyrynsalmi wishes to express his gratitude for the research grants given by the Nokia Foundation for his dissertation work on mobile ecosystems. The authors would like to acknowledge the valuable comments of three anonymous reviewers. Their fruitful comments have significantly impacted the quality of the manuscript.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.jss.2014.05.064.

References

Adner, R., 2012. The Wide Lens: A New Strategy for Innovation. Portfolio/Penguin, USA.

Amit, R., Zott, C., 2001. Value creation in e-business. Strat. Manage. J. 22 (6–7), 493–520.

Basole, R.C., 2009. Visualization of interfirm relations in a converging mobile ecosystem. J. Inform. Technol. 24 (2), 144–159.

Basole, R.C., Karla, J., 2011. On the evolution of mobile platform ecosystem structure and strategy. Bus. Inform. Syst. Eng. 3, 313–322.

Basole, R.C., Karla, J., 2012. Value transformation in the mobile service ecosystem: a study of app store emergence and growth. Serv. Sci. 4 (1), 24–41.

Basole, R.C., Russel, M.G., Huhtamäki, J., Rubens, N., 2012. Understanding mobile ecosystem dynamics: a data-driven approach. In: International Conference on Mobile Business. Paper 15.

Basole, R.C., Rouse, W.B., 2008. Complexity of service value networks: conceptualization and empirical investigation. IBM Syst. J. 47 (1), 53–70.

Blau, B., Weinhardt, C., van Dinther, C., Conte, T., Xu, Y.C., 2009. How to coordinate value generation in service networks. Bus. Inform. Syst. Eng. 1 (5), 343.

Bosch, J., 2009. From software product lines to software ecosystems. In: Proceedings of the 13th International Software Product Line Conference, SPLC'09 (Pittsburgh, PA, USA), Carnegie Mellon University, pp. 111–119.

Bowman, C., Ambrosini, V., 2000. Value creation versus value capture: towards a coherent definition of value in strategy. Brit. J. Manage. 11, 1–15.

Brinkman, R.L., Brinkman, J.E., 1997. Cultural lag: conception and theory. Int. J. Soc. Econ. 24 (6), 609–627.

Burkard, C., Widjaja, T., Buxmann, P., 2012. Software ecosystems. Bus. Inform. Syst. Eng. 4 (1), 41–44.

Cuadrado, F., Dueñas, J., 2012. Mobile application stores: success factors, existing approaches, and future developments. IEEE ASSP Mag. Commun. Mag. 50 (11), 160–167.

Curtis, S., Gesler, W., Smith, G., Washburn, S., 2000. Approaches to sampling and case selection in qualitative research: examples in the geography of health. Soc. Sci. Med. 50 (7–8), 1001–1013.

del Águila-Obra, A.R., Padilla-Meléndex, A., Serarols-Tarrés, C., 2007. Value creation and new intermediaries on Internet. An exploratory analysis of the online news industry and the web content aggregators. Int. J. Inform. Manage. 27, 187–199.

Desyllas, P., Sako, M., 2013. Profiting from business model innovation: evidence from Pay-As-You-Drive auto insurance. Res. Policy 42 (February (1)), 101–116.

de Reuver, M., Haaker, T., 2009. Designing viable business models for context-aware mobile services. Telemat. Inform. 26 (3), 240–248.

Edison, H., Bin Ali, N., Torkar, R., 2013. Towards innovation measurement in the software industry. J. Syst. Softw. 86 (5), 1390–1407.

Gambardella, A., McGahan, A.M., 2010. Business-model innovation: general purpose technologies and their implications for industry structure. Long Range Plann. 43, 262–271, http://dx.doi.org/10.1016/j.lrp.2009.07.009.

Gueguen, G., Isckia, T., 2011. The borders of mobile handset ecosystems: is coopetition inevitable? Telematat. Inform. 28 (1), 5–11.

Gummerus, J., Pihlström, M., 2011. Context and mobile services' value-in-use. J. Retail. Consum. Serv. 18 (6), 521–533.

Hanssen, G.K., 2012. A longitudinal case study of an emerging software ecosystem: implications for practice and theory. J. Syst. Softw. 85 (7), 1455–1466.

Hartmann, H., Trew, T., Bosch, J., 2012. The changing industry structure of software development for consumer electronics and its consequences for software architectures. J. Syst. Softw. 85 (1), 178–192.

Holzer, A., Ondrus, J., 2011. Mobile application market: a developer's perspective. Telemat. Inform. 28 (1), 22–31.

Hyrynsalmi, S., Mäkilä, T., Järvi, A., Suominen, A., Seppänen, M., Knuutila, T., 2012a. App Store, Marketplace, Play! An analysis of multi-homing in mobile software ecosystems. In: Proceedings of the International Workshop on Software Ecosystems, IWSECO'2012 (Cambridge, MA, USA), CEUR-WS, pp. 55–68.

Hyrynsalmi, S., Suominen, A., Mäkilä, T., Knuutila, T., 2012b. The emerging mobile ecosystems: an introductory analysis of Android Market. The 21st International Conference on Management of Technology, Hsinchu, Taiwan. Int. Assoc. Manage. Technol..

Hyrynsalmi, S., Suominen, A., Mäkilä, T., Järvi, A., Knuutila, T., 2012c. Revenue models of application developers in android market ecosystem. In: ICSOB 2012, LNBIP 114. Springer-Verlag, Berlin/Heidelberg, pp. 209–222.

Jansen, S., Cusumano, M., 2013. Defining software ecosystems: a survey of software platforms and business network governance. In: Jansen, S., Brinkkemper, S., Cusumano, M. (Eds.), Software Ecosystems. Analyzing and Managing Business Networks in the Software Industry. Edward Elgar, Cheltenham, UK, pp. 13–28.

Jansen, S., Finkelstein, A., Brinkkemper, S., 2009. A sense of community: a research agenda for software ecosystems. In: 31st International Conference on Software Engineering – Companion Volume, ICSE-Companion 2009, IEEE, pp. 187–190.

Kabbedijk, J., Jansen, S., 2013. Unraveling Ruby ecosystem dynamics: a quantitative analysis. In: Jansen, S., Brinkkemper, S., Cusumano, M. (Eds.), Software Ecosystems. Analyzing and Managing Business Networks in the Software Industry. Edward Elgar, Cheltenham, UK, pp. 322–333.

Katz, M.L., Shapiro, C., 1985. Network externalities, competition, and compatibility. Am. Econ. Rev. 75 (3), 424–440.

Kenney, M., Pon, B., 2011. Structuring the smartphone industry: is the mobile Internet OS platform the key? J. Ind. Compet. Trade 11 (3), 239–261.

Kim, H.W., Chan, H.C., Gupta, S., 2007. Value-based adoption of mobile Internet: an empirical investigation. Decis. Support Syst. 43 (1), 111–126.

Kleijnen, M., De Ruyter, K., Wetzels, M., 2007. An assessment of value creation in mobile service delivery and the moderating role of time consciousness. J. Retail. 83 (1), 33–46.

Lee, S., Kim, T., Noh, Y., Lee, B., 2010. Success factors of platform leadership in web 2.0 service business. Serv. Bus. 4 (2), 89–103.

Lepak, D.P., Smith, K.G., Taylor, M.S., 2007. Value creation and value capture: a multilevel perspective. Acad. Manage. Rev. 32 (1), 180–194.

Li, F., Whalley, J., 2002. Deconstruction of the telecommunications industry: from value chains to value networks. Telecommun. Policy 26 (9–10), 451–472.

Manikas, K., Hansen, K.M., 2013. Software ecosystems – a systematic literature review. J. Syst. Softw. 86 (5), 1294–1306.
Miles, M.B., Huberman, A.M., 1994. Qualitative Data Analysis: An Expanded Sourcebook, 2nd ed. SAGE Publication Inc., Thousand Oaks, CA.
Mladenow, A., Fuchs, E., Dohmen, P., Strauss, C., 2012. Value creation using clouds: analysis of value drivers for start-ups and small and medium sized enterprises in the textile industry. In: 26th International Conference on Advanced Information Networking and Applications Workshops, IEEE Computer Society, pp. 1215–1220.
Moore, J.F., 1996. The Death of Competition: Leadership and Strategy in the Age of Business Ecosystems. Harper Business, New York, NY.
Muegge, S., 2013. Platforms, communities, and business ecosystems: lessons learned about technology entrepreneurship in an interconnected world. TIM Rev. February, 5–15.
Mäkinen, S., Dedehayir, O., 2013. Business ecosystems' evolution – an ecosystem clockspeed perspective. In: Adner, R., Oxley, J., Silverman, B. (Eds.), Collaboration and Competition in Business Ecosystems. Advances in Strategic Management, vol. 30, pp. 99–125.
Ogburn, W.F., 1957. Cultural lag as a theory. Sociol. Soc. Res. 41 (3), 167–174.
Peppard, J., Rylander, A., 2006. From value chain to value network: insights for mobile operators. Eur. Manage. J. 24 (2–3), 128–141.
Suh, Y., Lee, H., Park, Y., 2012. Analysis and visualisation of structure of smartphone application services using text mining and the set-covering algorithm: a case of app store. Int. J. Mob. Commun. 10 (1), 1–20.
Teece, D.J., 2010. Business models, business strategy and innovation. Long Range Plann. 43 (2–3), 172–194.
Uncles, M.D., Kwok, S., 2013. Designing research with in-built differentiated replication. J. Bus. Res. 66 (9), 1398–1405.
Walgreen Co., 2012, March. Better Health Through Mobile – Walgreens Introduces New Pharmacy Tools to Help Smartphone Users Manage Prescription Needs [WWW Document]. http://news.walgreens.com/article_display.cfm?article_id=5560 (accessed 28.02.13).
Wall Street Journal, 2012, April. Insta-Rich: $1 Billion for Instagram. Facebook Inks its Biggest Deal Ever; Neutralizes Threat from a Hot Photo Start-Up. By Shayndi Raice and Spencer E. Ante. http://online.wsj.com/news/articles/SB10001424052702303815404577333840377381670
Weiblen, T., Giessmann, A., Bonakdar, A., Eisert, U., 2012. Leveraging the software ecosystem – towards a business model framework for marketplaces. In: Proceedings of the International Conference on Data Communication Networking, e-Business and Optical Communication Systems (DCNET, ICE-B and OP-TICS 2012). SciTePress, pp. 187–193.
West, J., Mace, M., 2010. Browsing as the killer app: explaining the rapid success of Apple's iPhone. Tele-commun. Policy 34 (5–6), 270–286.
Wingfield, N., 2012, October. From the Land of Angry Birds, a Mobile Game Maker Lifts Off – The New York Times technology [WWW Document]. http://bits.blogs.nytimes.com/2012/10/08/from-the-land-of-angry-birds-a-mobile-game-maker-lifts-off/ (accessed 28.02.13).
Xia, R., Rost, M., Holmquist, L.E., 2010. Business models in the mobile ecosystem. In: Proceedings of the 2010 Ninth International Conference on Mobile Business/2010 Ninth Global Mobility Roundtable, ICMB-GMR'10 (Washington, DC, USA), IEEE Computer Society, pp. 1–8.
Yin, R.K., 1994. Case Study Research: Design and Methods, 2nd ed. SAGE Publications, Newbury Park, CA.
Zott, C., Amit, R., 2007. Business model design and the performance of entrepreneurial firms. Organ. Sci. 18 (2), 181–199.
Zott, C., Amit, R., Donlevy, J., 2000. Strategies for value creation in e-commerce: best practice in Europe. Eur. Manage. J. 18 (5), 463–475.

Sami Hyrynsalmi is a nerd who has always enjoyed working with programming and computers. After graduating as Master of Science in Technology in software engineering from University of Turku in 2009, he decided to focus on the real issues and started his doctoral dissertation work on mobile application ecosystems. In addition to software and its production, his research interest covers also software business, software architectures and metrics as well as computer games.

Dr. Marko Seppänen is an Associate Professor technology and innovation management and the Director of Centre for Innovation and Technology Research (CITER) at the Tampere University of Technology. His research interests include technology and innovation management and strategy, focusing especially on business models and technology commercialization. He has published in such journals as Journal of Product Innovation Management, Technological Forecasting and Social Change, and International Journal of Physical Distribution & Logistic Management.

Arho Suominen, Ph.D., is Senior Scientist at the Innovation and Knowledge Economy unit at the VTT Technical Research Centre of Finland, also lecturing at the Department of Information Technology at the University of Turku. Dr. Suominen's research focuses on qualitative and quantitative assessment of emerging technologies and innovation management with a special focus on bibliometric methods. His research has been funded by the Finnish Funding Agency for Technology, Turku University Foundation and the Fulbright Center Finland. Through the Fulbright program, he worked as Visiting Scholar at the School of Public Policy at the Georgia Institute of Technology. Dr. Suominen has published work in several journals such as Futures, International Journal of Technology Policy and Management, and Chemical Engineering Science. Dr. Suominen has a Doctor of Science (Tech.) degree from the University of Turku and holds an Officers basic degree from the National Defence University of Finland.