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Author	B.G.J.C.M. Nederstigt Delft university of Technology

Abstract (structured along the lines of: background, aim, method, results, conclusion –150 words):

Digital multi-sided platforms (MSP) bring together different parties by enabling interaction between them. Unfortunately little is known on how digital MSPs can be designed. This research aims to contribute to solving this problem by adding knowledge on design principles of multi-sided platforms in the nascent stage of development using design science research. It does so by applying the design cycle of Verschuren & Hartog on the case of platform start-up company Checkmetrix. Execution of one full design cycle results in development of a MSP for the Dutch foodservice industry and the evaluation and development of six principles that can inform the design of early stage digital MSPs. The main contribution of this research is development of the principle that platform startups in markets where one side of the market is a large enterprise should focus on development of a value-creating product for a side of the market with small players.

Introduction

MSP's try to bring together different parties by enabling interaction between them. A key factor in this interaction is the presence of network effects, be it direct or indirect, and the purpose of the platform provider is to structure the platform in such a way that interaction cost between its participants is minimized (Hagiu, 2006; Rochet & Tirole, 2006). In case of direct network effects the platform's value is mainly increased if more users from one side join (e.g. only consumers), and in case of indirect network effects the platform's value depends on users in different groups (Katz & Shapiro, 1985). An example of indirect network effects can be found in mobile app stores. The app store (platform) becomes more valuable to consumers once more app developers join the platform.

A complication that arises when trying to design MSP's from the perspective of a start-up company, as is the case in this study, is that little research has been conducted with regard to how platforms come into being. More precisely it is unknown if products and services accidently evolve into platforms, or if platforms can actually be designed and engineered. This means literature is also lacking in principles that can guide the design of platforms. Something which is a problem because a well developed set of principles can help to design platforms more efficiently (Reuver, Sorensen, & Basole, 2016). Besides these problems the strategies that are usually applied by large, successful platform sponsors to achieve platform leadership might not be applicable for early-stage start up platforms that target large enterprise customers (Gawer & Cusumano, 2008).

The main question that is answered by this research is which design principles are useful for the design of a digital multi-sided platform for a start up company that enables market level data analytics and third party applications. Answering this question is done by employing the design cycle of Verschuren & Hartog (2005) in combination with a literature review of digital multi-sided platforms and the case of Checkmetrix. The case of Checkmetrix is especially fit to help answering the research question because the company is an early-stage start up that is trying to purposefully develop a digital MSP, in order to monetize on large enterprise clients as well as hospitality entrepreneurs.

Checkmetrix tries to provide a data analytics solution to the Dutch foodservice industry. A problem for collection of market data in the Dutch foodservice industry is the fact the hospitality industry is extremely fragmented, with the majority of its 22.280 cafes, hotels and restaurants employing less than 10 people. The same is the case for the logical place to collect any sales data, the point of sale system (POS). This market constitutes for a large portion of expensive legacy system manufacturers who are unwilling, or incapable, of integrating mobile solutions into their systems, and a small portion of more modern, cloud-based POS providers. This means that it is difficult, if not impossible for providers of data analytics solutions to integrate with a large amount of retailers. There is however a large need for market data because retailers and suppliers in the Dutch foodservice industry are facing increasing competition from new entrants to the market, like supermarkets and delivery services. The use of big data by large new players means that small hospitality owners and their wholesalers have much less insight into the wishes of the consumer, and are simply not as well equipped when it comes to influencing customer interaction. Especially compared to large supermarkets that have already invested much in the use of big data and online delivery services, the traditional foodservice industry lags behind when it comes to analytics (Corporation, 2013; Delta loyd, 2014; GfK, 2015; Rabobank, 2016).

Checkmetrix has developed a device that can connect to any existing POS system. Because this device (called Printerbox) can connect to any existing POS system it has the potential to be easily integrated in the existing retail environment, share data between stakeholders from the foodservice industry, and that way become a multi-sided platform (MSP) for all kinds of data-analytics solutions.

By studying the case of Checkmetrix this research contributes design principles to platform literature. Five existing design principles are evaluated as useful for the design of a digital MSP in the foodservice industry, while two are not relevant for start-ups and one could not be tested. The main contribution of this research is the development of an extra guideline. This guideline states that platform start-ups in markets where one side of the market is a large enterprise should focus on development of a value-creating product for a side of the market with small players, in order to reduce complexity, level the playing field with potential platform participants, and attain critical mass before connecting larger participants.

The remainder of this paper is structured as follows. The next section embeds this research in the broader spectrum of IS design literature by defining digital MSP's and extracting eight principles that can inform design of the Checkmetrix platform. This is followed by a more in-depth discussion of the Checkmetrix case. Following this the methodology section describes the design approach used, as well as the evaluation methods. After this the paper continues with a description of the designed platform and the interview results in the results section. This is followed by the conclusion that it is possible to design a digital MSP for data analytics in the foodservice industry. Finally the implication for theory that the process model of MSP development must be extended, together with directions for future research are presented in the discussion section.

Literature review

The main purpose of this section is the extraction of design guidelines from state of the art literature that can inform design of the Checkmetrix platform. But because one of the main risks holding back the field of IS-design theory regarding digital MSP's is the lack of conceptual rigor in IS-design literature, this section will start of by providing a clear definition of digital MSP's based on state of the art literature (Reuver et al., 2016). Following this design principles from the different streams on platform literature are extracted in their respective sections. First the economical perspective on platforms is discussed in the section economical perspective. This is followed by the digital characteristics of platforms in the digital perspective section. A discussion of platform ecosystems and governance is presented in the section ecosystems & governance. Finally the different stages of a platforms lifecycle are discussed.

Defining digital multi-sided platforms

From an economical perspective the main idea behind multi-sided platforms is that they enable interaction between multiple groups of users (Rochet & Tirole, 2006). One of the main ideas of the economic perspective is that the platform becomes increasingly more valuable as more users join because of network

effects. Different thoughts exist as to what the main purpose of a platform should be. According to (Eisenmann, Parker, & Alstyne, 2006) it is to provide the rules and infrastructure that enable interaction between the different user groups. Boudreau & Hagiu, (2009) on the other hand argue that a platform owner tries to reduce search costs and/or transaction costs among all sides of the platform. The transactions are facilitated in such a way that members of one side are more likely to get on board than members on a different side of the platform.

Researchers from the field of IS are using different terms and definitions to refer to platforms. Tilson, Lyytinen, & Sørensen, (2010) refer to platforms as 'digital infrastructures'. They define these infrastructures as "*the basic information technologies and organizational structures, along with the related services and facilities necessary for an enterprise or industry to function.'* Tiwana, (2013) uses the term 'software platform' and defines it as "*The extensible codebase of a software-based system that provides core functionality shared by the modules that interoperate with it and the interfaces through which they operate".*

The common element in all definitions of platforms across the different streams of research is that they have modular architectures. This results in platforms with a stable core and variable periphery (C. Y. Baldwin & Woodard, 2008; Nikayin, 2014). This modularity allows new products and services to be added on top of the platform, that way mediating between different participants of the platform's network.

This research specifically looks to create value by enabling interaction between different stakeholders in the foodservice industry through the use of a software system. Because of this the definition used in this research is formulated in the following manner. *A digital multi-sided platform is the modular, extensible codebase of a software-based system along with the organizational structures and interfaces, that creates value by mediating between different participants of the platform's network*

Economical perspective

The presence of network effects means that platforms can grow extremely fast. As more users join the attraction towards other users, in the same or other groups, is increased even further. A challenge that platform providers face before this happens is the critical mass constraint. For a platform to become attractive to the masses it must first secure enough participants on all sides of the platform. It is suggested that for platforms to survive at all they must solve this so called 'chicken and egg' problem before the platform is launched (Evans & Schmalensee, 2010).

Most of the economic scholars agree that the main challenge multi-sided platform providers need to get right in order to create a profitable platform is their pricing strategy. Although it should be possible to monetize on all sides of the platform it is usually smart to subsidize a specific side. This can even go as far as giving away products for free to one side, in order to attract more users from the other side. The main factors influencing pricing strategy should be the ability to capture cross-side (indirect) network effects, user sensitivity to price and quality, same-side (direct) network effects and users' brand valuation. When appropriately analyzing these factors it should be possible to find the 'marquee' user. This so-called marquee user has an exceptional influence compared to the rest of the players in the market, and it can be profitable to subsidize this player. It could for example be a good idea to give a discount to the biggest shop in the shopping mall to attract other, smaller shops (Bakos & Katsamakas, 2008; Eisenmann et al., 2006; Parker & Van Alstyne, 2005; Rochet & Tirole, 2006). According to these authors applying pricing strategies in the correct manner will lead to winner-takes all behavior. The main ingredients for successfully taking control of a multi-sided market are at the least cost or differentiation advantages (Eisenmann et al., 2006).

Guideline 1: Solve chicken and egg problem before launching platform by subsidizing quality and price sensitive users, in order to quickly attain critical mass

Some of the more recent literature on multi-sided platforms suggests this winner-take all approach might not be as unconditional as presented in the previous works. CennamO & Santalo, (2013) and Holzer & Ondrus, (2011) show that if multiple platform providers leverage aggressive pricing strategies to grow their user base on all sides it not only diminishes the effect of the strategy, but it is even detrimental to platform performance. They find that it is often possible for platforms to successfully capture a niche market by using distinctive positioning. Instead it is suggested in their work that companies should have a clear vision and business model which tries to balance the nuanced trade-off between pricing strategy, portfolio growth and user attraction. This idea is supported in Hagiu, (2006) and Boudreau & Hagiu, (2009). Both of these studies show that platform providers have much more strategic instruments available to them besides pricing strategies. Using empirical research Boudreau & Hagiu, (2009) show that instruments used by platform providers include investments, technology rules, information dissemination, and contracting choices besides price differentiation.

Guideline 2: Create clear vision and business model that balances pricing strategy, portfolio growth and user attraction, in order to deal with complex environments

Digital perspective

Although innovation management and economic research on platforms has been relatively successful in analyzing platforms from their respective perspectives this approach is not sufficient for digital multi-sided platforms. Digital platforms in IS research are set apart from their economical and innovative counterparts because they have different characteristics. First of all Yoo, Henfridsson, & Lyytinen, (2010) describe reprogrammability, homogenization of data and the self referential nature of digital technology as the main items that set digital platforms apart. Kallinikos, Aaltonen, & Marton, (2013) add to this editability, composability, distributedness and openness as defining characteristics of digital platforms.

Reprogrammability of data means that functional logic is separated from the device on which it is executed resulting in the ability of a single device to perform multiple functions (e.g. browsing the internet and listening to music). Homogenization of data in turn separates the content from the medium because all data can be accessed using the same devices and networks. Combining these two characteristics with the self-referential nature ultimately results in the democratization of innovation. The fact that digital innovation requires digital devices causes the creation of positive network effects that further increase the development of digital devices and content. These network effects help to continuously lower barriers of entry and learning costs, making digital technology, and its development available to almost anyone (Yoo et al., 2010).

In their paper Yoo et al., (2010) present the layered modular architecture as a means to design digital product platforms that enable to creation of multi-sided markets and their corresponding ecosystems. The reprogrammability characteristic means that device and service are separated, and homogenization of data causes the separation of network and contents. This results in the following so-called layered architecture.

Because the layers represent different design hierarchies design decisions for components in each of the respective layers can be made without considering the structure and design of any of the other layers. This gives designers flexibility in the creation of the final product by combining components from different layers. The layered architecture can be combined with a modular architecture. Modularity is a general characteristic of complex systems and refers to the degree to which a product can be decomposed into products that can be recombined (Schilling, 2000). The main advantages of a modular architecture are increased flexibility and reduced complexity. Besides this modularity encourages innovation by decentralizing decision making on hidden modules, and creates the option for third parties to innovate on a module (C. Baldwin & Clark, 2000). When combining the modular architecture with a layered architecture the so-called layered modular architecture can be derived. In this architecture there is no fixed product boundary, which means little knowledge of the final product is required to design a component. Because components can be designed freely and bound together through loosely coupled layers new unforeseen innovations can be created by complementary providers, something which is called generativity (Tilson et al., 2010; Yoo et al., 2010). From this the following design guidelines can be distilled.

Guideline 3: Components of digital platforms must be loosely coupled through standardized interfaces, in order to reduce system complexity.

Guideline 4: Layers must be coupled through standards and protocols shared by heterogeneous firms, in order to increase connectivity between platform participants.

Guideline 5: Platforms must be generative and evolvable, in order to promote innovation on the platform by platform participants

Ecosystems & governance

As can be seen in the previous paragraphs all streams of literature incorporate the concept of interaction between multiple groups of stakeholders, either through network effects, or in the digital perspective through distributed innovation thanks to layered modular architectures. It can even be said that platforms do not have a single core owner (Henfridsson, Mathiassen, & Svahn, 2014). This means a discussion of digital multi-sided platforms should also include a discussion of their ecosystems, and how to deal with the governance challenges that come with a complex environment of stakeholders (Reuver et al., 2016). The concept of biological ecosystems as a comparison to business ecosystems is particularly useful because the fate of each of the members in the business network is tied to the fate of the other participants, as is the case in a biological ecosystem. The complex interdependencies among companies in a network cause the network as a whole to become more innovative and productive. At the same time the moves a company makes will impact the health of the business network, which ultimately reflects on the businesses' own health (Iansiti & Levien, 2004).

The work of Iansiti & Levien, (2004) focuses on how a company can become a keystone actor within an ecosystem by first, creating value within the ecosystem, and secondly, sharing this value with the rest of the ecosystem. Keystone organizations are crucial members in a business ecosystem that try to improve the overall health of the ecosystem so that they can in turn benefit from this as well. Examples of keystone organizations are Microsoft and eBay. A similar approach is taken by Gawer & Cusumano, (2014). In this work the authors provide guidelines on how to obtain, or maintain platform leadership. According to them one of the main challenges for platform providers is to take coherent business, technology and design decisions, in order to successfully navigate the complex strategic landscape where competition and collaboration occur between different actors. To become a platform leader an organization must first build a vision of how their product, technology or service can become part of a larger ecosystem, and then build a coalition around "the right technical architecture". By sharing risks with complementors and creating benefits for partners in the ecosystem the organization can build up a reputation as a neutral industry broker. This way a sustainable ecosystem with the organization at its core can be created in the long term.

Guideline 6: Build a coherent vision of what the platform and its ecosystem should look like, to help build a reputation as neutral industry broker

Guideline 7: Build strong partnerships with partners who share the platform vision, in order to reduce risk and increase power for the platform owner

Platform lifecycle

As is pointed out by Reuver et al. (2016) there is a lack of research on platforms during early stages of development. Most research is performed ex-post on successful platforms, and there is a lack of research on failed platforms and how platforms come into being. One of the few works that focuses on platform development from an early stage is the work by Tan, Lu, Pan, & Huang, (2015). They develop a maturity model that distinguishes between the different stages of platform development, and identify different strategies suitable for each stage by looking at the case of Chinese trading platform Alibaba from the perspective of IS capabilities.

The stage that is currently most relevant to this research is the nascent stage. In this earliest stage of platform development platform providers should focus on inside out IS capabilities and use a coring and tipping strategy to build a hub-and-spoke platform. Inside out IS capabilities that are specifically important are the IS infrastructure and IS technical skills. The hub-and-spoke platform is the simplest form of a platform, enabling simple, direct interaction between two parties (e.g. buyers and sellers) (Tan et al., 2015).

The coring and tipping strategies, developed in Gawer & Cusumano (2008) work as follows. In case of 'coring' platform providers try to solve an essential system problem for many industry players by creating a platform were no platform existed before. Add-ons by external complementors are facilitated, but the core technology remains proprietary. Key aspect of this strategy is that the service offered by the platform provider is value creating. Tipping on the other hand is especially useful when trying to win a platform war. By creating unique and compelling features that are hard to imitate, possibly bundling features from a platform in an adjacent market, it might be possible to tip the market in favor of the platform provider.

Gawer & Cusumano, (2008) also note that although small and medium sized companies as well as large companies can apply these strategies, smaller companies might have a hard time negotiating with large enterprise customers. Smaller companies will find it difficult to tip markets, and might need to establish ecosystem partnerships or coalitions of providers and users. Although this point seems logical they provide no empirical evidence to uphold it.

Guideline 8: Nascent stage platforms should use coring and tipping strategies, in order to develop a hub & spoke MSP.

Case background

The platform that start up company Checkmetrix is looking to develop will have to operate in a complex environment with stakeholders of different sizes and interests. The case is especially useful for testing the utility of the previously extracted principles because the company is an early stage start-up with the goal of monetizing on all sides of the market. This section provides background information on the case by giving an overview of the Dutch foodservice industry (hospitality and its supply chain), as well as data analytics solutions available for the foodservice industry. Understanding the platform's ecosystem will provide context necessary to understand the need for the Checkmetrix platform as well as a basis for understanding the rest of this research.

Foodservice industry

The foodservice industry spans the entire value chain of hospitality (bars, restaurants, hotels) together with the wholesalers and producers that supply them with goods for their customers. Besides bars, restaurants and hotels the foodservice industry also entails comfort (delivery services) and catering. For the purpose of this research the focus will be on the hospitality together with its supply chain.

The hospitality part of this industry is made up of hotels (28%), cafes (17%), and restaurants (41%). A majority of the 22.280 enterprises in this market (hotels excluded) has less than 10 employees, making it a fragmented market (Delta loyd, 2014). Although the market is mature and stable, with an expected annual growth of +/- 3% hospitality entrepreneurs will have to look for economies of scale by cooperating with recreation, retail and other hospitality enterprises in order to stay competitive. Especially finding the right online proposition will be important for them to prevail (Rabobank, 2015a).

Wholesalers mainly supply hospitality entrepreneurs in the foodservice industry. This part of the market is dominated by five large players who together account for about 60% of the market, and even 75% on the purchasing side of the market through buying partnerships. Wholesalers purchase their goods from the fast moving consumer goods (FMCG) industry. It is expected that the FMCG industry will continue to grow by about 2% annually. Most of this growth will however be the result of export and growing markets in Asia, South-America and Africa. Volumes for the Northern European market are expected to stabilize at the current level. This industry is marked by a consistent increase in integration, economies of scale and consolidation (AMRO, 2012; Rabobank, 2015b; Sligro, 2015).

Currently the entire foodservice industry is facing huge competition from players outside the industry. Key new competitors are supermarkets and reservation / delivery websites. The use of big data by large players means that small hospitality owners and their wholesalers have much less insight into the wishes of the consumer, and are simply not as well equipped when it comes to influencing customer interaction. Especially compared to large supermarkets that have already invested much in the use of big data and online initiatives the traditional foodservice industry lags behind when it comes to analytics (Rabobank, 2016).

Key parties for modernization of market research in the foodservice industry are manufacturers of POS systems. A POS system is the place where a transaction occurs between the customer and bar/restaurant. The market for POS systems is quite fragmented. In total there are over 130 suppliers of POS systems in the Netherlands who together offer more than 250 different systems. Although automation of large (supermarket) chains is mainly fulfilled by about 7 suppliers (making them market leaders), the majority of the market (about 75%) focuses on enterprises with just 1 or 2 venues and 1 or 2 points of sale per venue ("Het aanbod van kassasystemen | Checkout," 2015).

Traditionally POS providers are known to be quite hesitant when it comes to opening up their systems to third parties and offering integrations. Their focus is very much on stability, and guaranteeing delivery of service. More recently POS manufacturers do start to feel the pressure from new entrants to the market that offer modern, cloud based solutions. These cloud-based parties are more open to integrating with third parties and allow easier extraction of data. Over the full retail market about 16% of suppliers currently have one or more POS systems with cloud backend and 26% offer one or more full cloud solutions. Another 38% are developing at least a cloud backend. It is however expected that these percentages are lower for the hospitality industry ("Het aanbod van kassasystemen | Checkout," 2015).

Even though suppliers are now actively developing cloud based solutions it can be expected that it will take a long time before a large part of the market actually changes to one of these solutions. This is because the high costs of computerized POS systems. Especially in the hospitality these systems need to be robust and can cost up to 8.000 Euro per terminal. Because hospitality enterprises aim to only spend about 1,5% of their revenue on electronics and inventory a new POS system is a huge investment for them (Delta loyd, 2014).

Data analytics

The fragmentation in the hospitality sector and on the POS market means there is no unified solution to collect sales data in the foodservice industry. Most of the market insights are currently collected in three main ways. A commonly used solution is market data and analyses from Nielsen. By integrating with POS and back-office systems Nielsen collects very detailed data that allows deep insights in to the market. This data contains nearly no information regarding the hospitality industry because rolling out such a solution is challenging due to the fragmented market of hospitality entrepreneurs and POS providers. The second solution is retrieving data through companies like Gfk and Datlinq. Although these companies offer insight in the foodservice market they mainly collect their data through the use of consumer panels, or visits to hospitality venues. This means the data they provide only shows a limited or outdated view of the market. Besides the large market research companies several (start-up) initiatives exist that try to enable market research in the hospitality industry Although all of

these solutions provide the type of data that are needed to really dive into consumer preferences and market analytics they all have a small-scale collection method. All of the solutions rely on the installation of sensors (time consuming), POS replacement (high barrier for hospitality entrepreneurs) or consumers (unreliable) for collection of their data. This means it will be hard to get a complete overview of the market using these solutions.

Checkmetrix

The Checkmetrix team thinks it holds technology that can provide the foodservice industry with the market research it requires to better compete with new entrants to the market. Besides this the team thinks it can monetize on this technology by developing a multi-sided platform that connects suppliers from the foodservice industry with bars & restaurant from the hospitality industry.

They developed a device called the Printerbox that can connect to any existing POS system. The Printerbox send all data to the Checkmetrix platform where it is either analyzed, or passed to third parties who then do their own analytics on the data. Possible types of analyses are

- In-store for specific retailers (e.g. How much products are sold, what are peak hours etc.)
- Benchmarks with different retailers
- Trend analysis (Which product sales are rising, decreasing etc.)

The Checkmetrix team thinks that one side of the platform, the food service industry suppliers, is highly interested in market research data, and willing to pay a lot of money for this data, because food service suppliers can use it to create a competitive advantage. It is expected that indirect network effects will play an important role for attracting foodservice suppliers. The platform becomes more valuable to them once more hospitality entrepreneurs join. The Checkmetrix team also thinks the other side of the platform, the hospitality entrepreneurs, will show some interest in data analytics because the analytics can help them to improve the performance of their hospitality enterprises. It is expected that hospitality entrepreneurs are willing to pay a small amount of money for data analytics. For hospitality entrepreneurs direct network effects are especially important. For them the platform becomes more valuable once more entrepreneurs join because they can then use the platform for trend analysis and benchmarking.

Methodology

This section describes the general design approach of this study in the next section. Following this the evaluation of assumptions and the designed artifact is described more in depth in the section evaluation method.

Design approach

According to Verschuren & Hartog, (2005) design has been recognized for a long time as both an art and a science. But in order to continuously move the field of Information Systems (IS) forward it is important to take a systematic and scientific approach to research in this field. Because of this scholars have for some time now worked on the development of design science research (DSR) methodologies. The design-science paradigm has its roots in engineering and is fundamentally a problem-solving paradigm. By creating and evaluating IT artifacts intended to solve organizational problems DSR tries to extract knowledge that aids in the productive application of information technology to human organizations and their management. The results of DSR include not only artifacts but also knowledge on how to design other artifacts in the same class of problems. This knowledge is often referred to as design principles (Hevner, March, Park, & Ram, 2004; Vaishnavi & Kuechler, 2004).

Gregor & Hevner, (2013) developed a framework for design science research contribution. They argue that design science research (DSR) should first of all be classified according to the type of contribution. The types of contribution depend on maturity of the knowledge. Level 1 is a situated implementation of an artifact, level 2 is nascent design or knowledge as operational principles, and level 3 is well-developed design theory. Secondly a DSR project should be categorized along two axis, being problem maturity and solution maturity. Depending on the maturity of these two project characteristics a project can either be routine design, an improvement, an invention, or an exaptation.

In the case of this research the concepts relating to design of digital multi-sided platforms is applied to a new domain, that of data analytics in the foodservice industry. Because of this the research can be classified as

exaptation research. The fact that an existing solution is being applied does not make the research less relevant. In fact, the new uncertain environment in which the solution is applied, allows for the development of new theoretical constructs. By reflection on the design process, and thorough evaluation of the artifact this knowledge might be transposed to different projects. Development and evaluation of design principles means that the expected knowledge contribution can be classified as level 2, nascent design or operational principles, in the maturity model of (Gregor & Hevner, 2013).

To structure the design of the artifact this research uses the design cycle of Verschuren & Hartog, (2005). Their approach to Design Science Research (DSR) specifies a design cycle consisting of six steps. Although the process is represented linearly it should be noted that the actual design is often incremental, and especially evaluation should take place during all steps of the design cycle. The different steps are displayed below.

1. First hunch
2. Requirements and assumptions
3. Structural specifications
4. Prototype
5. Implementation
6. Evaluation

This approach is especially suitable for the problem at hand because it pays a lot of attention to the requirements of the different stakeholders involved. Combined with the continuous evaluation of the different design steps this will help to create an artifact that meets the expectations of all parties involved, because the validity and soundness of the design is continuously tested. Continuous evaluation during the entire process also helps to keep track of all design decisions, so that these might be extracted into more general scientific knowledge (design principles) during the final evaluation.

Requirements analysis

To evaluate the main assumptions underlying the rest of the design and extract requirements of the platform, interviews were conducted. Eight semi-structured interviews were held amongst entrepreneurs from the hospitality industry, as well as five meetings with representatives of large foodservice suppliers. Semi-structure interviews are especially suitable for testing assumptions because they allow extracting information on a range of topics while also allowing new ideas to be brought up.

We strived to cover a broad range of potential users. Therefor, the businesses owned by entrepreneurs interviewed range from businesses with single venues, an annual revenue of 150.000 euros and no employees, to businesses with over ten venues, revenues of more than five million per venue and 80 employees per venue. This means the enterprises of interviewees represent restaurants throughout the entire range of size groups of the Dutch hospitality industry. The interview consisted of 20 questions that each help in testing one or more of the assumptions.

To evaluate assumptions regarding suppliers five meetings were held with representatives of FMCG companies, wholesalers and large brewers. The meetings were used to extract information regarding the corporations' requirements of a data analytics product, and possible barriers for cooperation between Checkmetrix and the supplier companies. The companies included are Heineken, AB-InBev, Vrumona, Pesico and Friesland Campina. The reason these suppliers are included is that they were immediately interested in the Checkmetrix product. Together these parties are responsible for production of most beverages available in the Dutch hospitality, and thereby a good reflection of the FMCG market. Securing meetings with these parties was possible through a partnership with platform/software as a service provider Salesforce. Salesforce is a strong partner of Checkmetrix that shares the platform vision and helps to increase credibility of Checkmetrix (influenced by guideline 7).

Evaluation

To evaluate the artifact interviews were conducted with potential users. Potential users of the Checkmetrix dashboards are hospitality entrepreneurs with a medium to large sized business (500.000 - 3.000.000 euro revenue per year). This selection is made based on the first round of interviews in which owners of small venues (< 500.000 annual revenue) indicated no interest in data analytics, and the interviewed owners of large enterprises indicated to already have sufficient data analytics solutions in place

Results

This section discusses the results of the research in three phases. The first design step is results of the initial interviews with hospitality entrepreneurs and foodservice suppliers; these results are presented in the section requirements & assumptions. These interviews are the main informant for design of the first version of the platform; this is presented in the second section, platform design. Finally the results of evaluation of the platform are presented in the final part of this section.

Requirements & assumptions

There were several assumptions underlying the initial idea of the platform. Those assumptions were informed by the principles from platform literature as well as knowledge of the foodservice industry. An important step in the design process of the initial platform version was validation of those assumptions. This section describes how the assumptions were evaluated.

Hospitality entrepreneurs

From the interviews it can be concluded that the main interest from retailers regarding Checkmetrix products is two-fold. The main problem they currently have regarding data analytics is combining their different administrative tools and performing analysis on them. Checkmetrix could add most value for them if the platform became a key element in integrating the different data sources (accounting software, POS system, personnel scheduling, inventory management), combined with easy data insights (graphs/overviews). A second option that especially the larger enterprises seem to be interested in is automatic recognition of diverging patterns in their data.

Suppliers

All interviewed suppliers indicated they are interested in higher quality market research but are currently not able to collect sufficient, and sufficiently precise data because they have no connection to the consumer, and the enterprises selling their products. Suppliers also indicated willingness to pay large amounts of money (100-500 euro per venue for a half year pilot) in case the data analytics platform meets their requirements. Currently all of the foodservice suppliers see several barriers that must be overcome before they would consider doing a pilot with Checkmetrix. Because of this the assumption that food service suppliers trust Checkmetrix to supply them with better data analytics is partially invalidated. Although foodservice suppliers indicated no trust in Checkmetrix at this moment, they remain interested in a more mature solution.

Checkmetrix expected to solve the chicken and egg problem before launching the platform (G1) by partnering with large foodservice suppliers (G7). The fact that suppliers indicated no interest in the current platform has implications for the strategy of Checkmetrix. First of all Checkmetrix should focus on validating that it can create a solution that attracts sufficient hospitality entrepreneurs to become interesting to foodservice suppliers. Once it is validated that Checkmetrix can create a valuable product for the hospitality industry it can start implementation of its artifact. Once sufficient hospitality enterprises are connected, the company can once again try to attract customers from the foodservice industry. This means that the remainder of this study focused on creating a platform that creates value for the hospitality industry, and does not (yet) incorporate suppliers from the foodservice industry.

Platform design

Because suppliers indicated no interest in the Checkmetrix platform until it matures the choice was made to develop an analytics solution for hospitality entrepreneurs. Such a product should be designed with the platform function in mind so that connections to suppliers can easily be made in a later stage. The rest of this section describes the designed product. First the ecosystem and organizational arrangements of the platform are discussed in the next section. Following this an overview of the architecture is presented in the section architecture. Finally interfaces to the hospitality entrepreneurs are presented in the last section, dashboards.

Ecosystem

The initial version of the platform will only include interactions between hospitality entrepreneurs and Checkmetrix. In return for a monthly fee and transaction data from the hospitality enterprises, Checkmetrix will provide analytics to the entrepreneurs. An overview of the value network depicting these interactions is displayed in Figure 1 - Platform ecosystem. This overview of the platform ecosystem is especially informed by

guidelines G2 and G6. The ecosystem design communicates the platform vision and business model and in that way it helps to deal with environmental complexity.

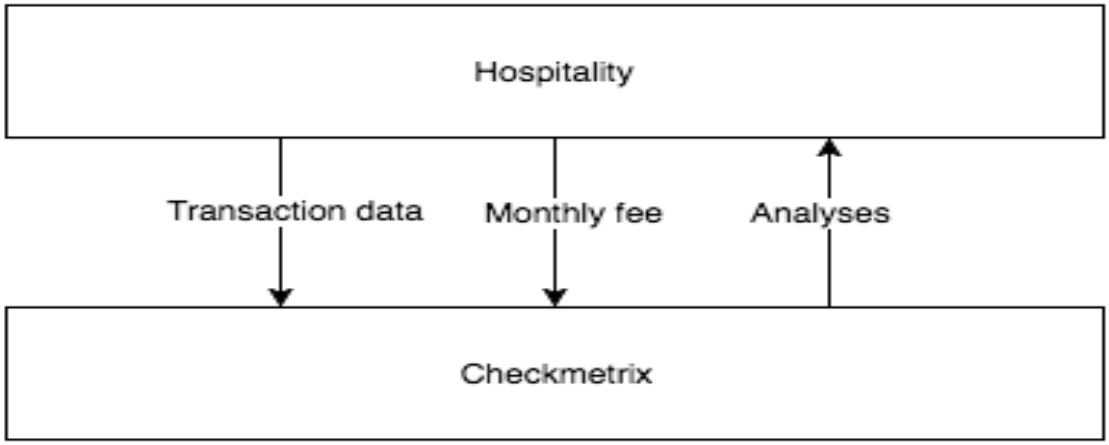

Figure 1 - Platform ecosystem

Architecture

A key element for a generative and evolvable platform is decomposition of the platform into different layers and modules that help to reduce complexity and increase flexibility (G4). To keep the modules manageable they must in turn be loosely coupled through standardized interfaces (G3). Figure 2 - Platform architecture displays the main modules of the Checkmetrix platform and how they interact.

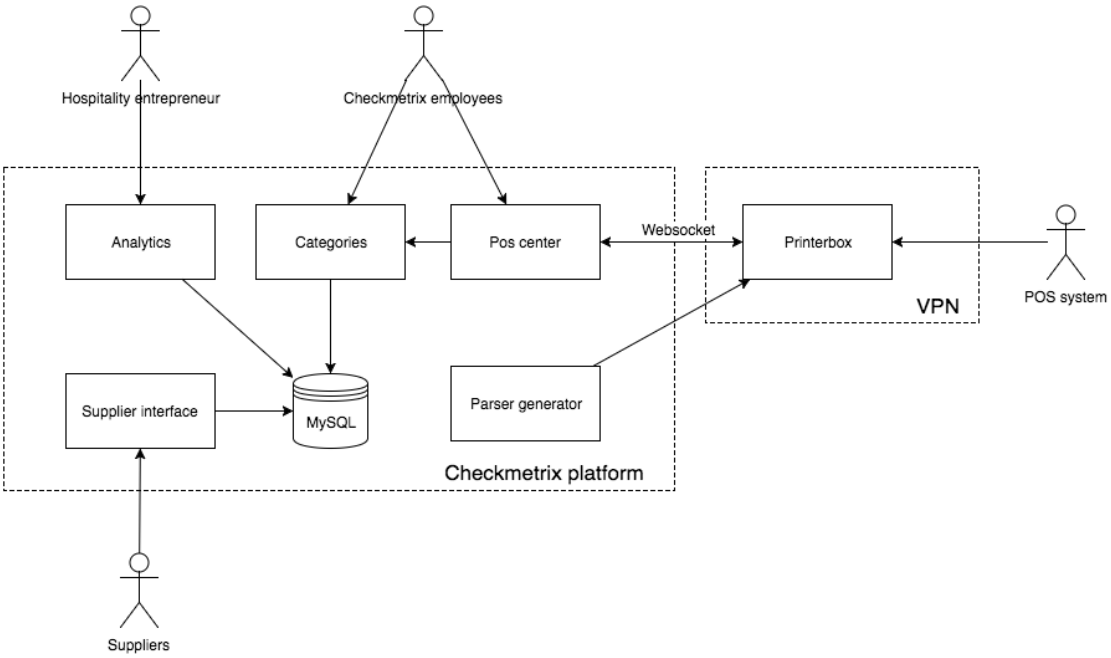

Figure 2 - Platform architecture

The POS-center module displayed in this figure is responsible for ingesting data from the hospitality enterprises. This data is captured using a device developed by Checkmetrix that connects to any existing POS system. Ingested data is then categorized, tagged and stored for analysis using the Categories module. Finally, the Analytics module is used to display dashboards to hospitality entrepreneurs based on data collected from their enterprises. The modular, extensible architecture of the platform allows to easily add interfaces to suppliers in a later stage.

Dashboards

Besides the technical architecture of the platform mockups of several dashboards were created. Mock-ups are a quick and easy way to create a reflection of what the actual Checkmetrix product might look like. The

mock-ups are actual graphs made from a test data set. This data is partial data from a collection of actual bars and restaurants that has been anonymised and collected after the bar owners gave their consent. An example of a dashboard is displayed in Figure 3 - Dashboard example. The top chart of this dashboard displays the revenue distribution per product group throughout the week for a restaurant. The bottom chart displays the revenue distribution per table for the same restaurant.

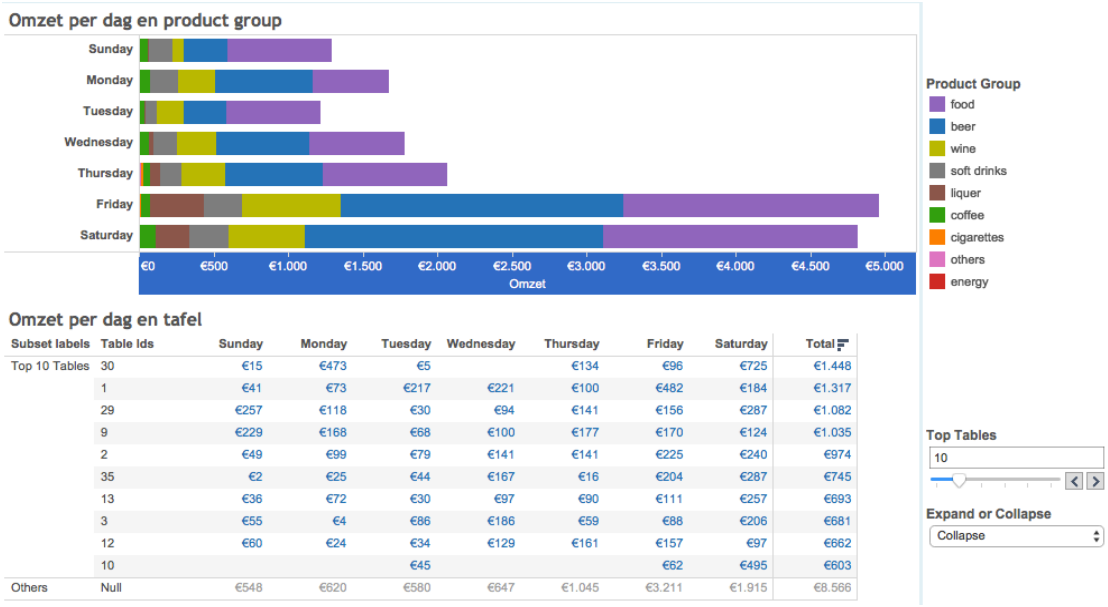

Figure 3 - Dashboard example

Platform evaluation

The designed artifact was evaluated to test if it contributes to fulfilling the goals of the problem owner. To evaluate whether building a data analytics platform by first convincing hospitality entrepreneurs to join is a viable strategy three assumptions had to be evaluated.

Hospitality entrepreneurs are interested in data analytics

The assumption that hospitality entrepreneurs are interested in data analytics because it can help them to increase the performance of their enterprises has been evaluated using two questions.

1. Will they the dashboard on a regular basis?
2. Must any extra functionality be included?

From the interviews it can be concluded that the hospitality entrepreneurs will use the dashboards on a regular basis (weekly in most cases, monthly in one case). Key functionality that must be included to make the dashboards really useful for the entrepreneurs is the possibility to add personnel schedules and costs. However, entrepreneurs indicated they would use the dashboards even in the current state. Because of this the assumption that entrepreneurs are interested in the dashboards because they can help to increase the performance of their enterprises is validated.

Hospitality entrepreneurs are willing to pay for data analytics

The assumption that hospitality entrepreneurs are willing to pay a small amount of money for data analytics was validated using two questions. One question checked if the dashboards saved them time in management activities (and therefor money), and the second question tested if, and how much they are willing to pay for the dashboards. From the interviews it can be concluded that the dashboards will not save the entrepreneurs any time (except for a few cases where there is no analytics in place whatsoever), but entrepreneurs are still willing to pay 20 – 100 euros per month for the current solution. In case more functionality (like personnel schedules) is added, they are willing to pay more money. Because of this it can be concluded that this assumption has been validated.

Hospitality entrepreneurs are willing to share their data

By asking if entrepreneurs are willing to share their data it becomes clear that the dashboards are more than enough remuneration for all but one the hospitality entrepreneurs to share their data on a platform. All of those entrepreneurs indicate no issues whatsoever with aggregation of their data on a platform, as long as the data cannot be traced back to their specific enterprise. Because of this it can be concluded that the assumption has been validated.

Conclusion

The main purpose of this research was to answer the following question *which design principles are useful for the design of a digital multi-sided platform for a start-up company that enables market level data analytics?* The case of Checkmetrix allowed evaluating the usability of existing principles from the field of digital MSP's. Design science literature informed the methodology that allowed concretizing the steps needed to manage the designing process. More specifically the design cycle by Verschuren & Hartog (2005) allowed structuring of the design process. Execution of one full design cycle resulted in the development of a data analytics solution for hospitality entrepreneurs.

Mock-ups of dashboards were created, and hospitality entrepreneurs evaluated these positively. In fact, interviews with hospitality entrepreneurs showed that the dashboards fulfill the goals of the problem owner because hospitality entrepreneurs are willing to pay for the dashboards, would use them on a regular basis, and are also willing to share the data collected from their enterprises on a platform. Based on interviews with suppliers from the foodservice industry it is expected that if hospitality entrepreneurs do indeed adopt the platform, and data from the hospitality industry is successfully collected on the platform, that foodservice suppliers are willing to join the platform as well. The successful development of this initial version of the Checkmetrix platform allows drawing conclusions for each of the extracted principles from literature.

Critical mass guidelines

There are two guidelines related to the attainment of critical mass, being G1 and G7. First of all G1 considered solving the chicken and egg problem by subsidizing quality and price sensitive users in order to quickly attain critical mass. From the perspective of an early-stage start up with only little funding this meant forming strong partnerships (G7) and quickly securing marquee users to raise sufficient funds for any subsidies. Because this turned out to not be possible it can be concluded that G1 is hard, if not impossible to apply for early stage start-ups. Although it was expected that G1 might be hard to execute it was also expected that this problem could be mitigated using G7, however this turned out to not be the case.

Building strong partnerships with partners who share the platform vision (G7) turned out to be moderately helpful. Even though subsidizing users was not possible through this strategy, the partnership with Salesforce helped to secure initial meetings with foodservice suppliers. Although it was not possible to create any partnerships with strong partners it is still expected that securing those partnerships in a later stage will help in reducing risk and attracting more users. Because of this the guideline might still be useful in situations where a partnership might be created.

Technological guidelines

Guidelines G3, G4 and G5 appear to be useful in structuring the technical artifact. The current system is designed using these guidelines and it is expected that any future changes can be made with a relatively small effort. More research will however be needed once these changes are actually made to confirm this premise. G3 and G4 especially influenced the layered, modular design of the artifact. When designing the platform development of a single module was considered as well, because it can be expected that this will result in lower cost and higher performance in the short term. Instead G3 and G4 informed a modular architecture as this offers greater flexibility, an important characteristic because the current artifact will need to be greatly expanded.

Generativity on the platform is especially expected from foodservice suppliers and third parties. This is because hospitality entrepreneurs indicated during the interviews that they want to spend as little time as possible on doing analytics, and third parties and foodservice suppliers are expected to gain the most from development of new applications (NB. they can use the platform to reach the entire foodservice industry, whereas hospitality entrepreneurs focus mainly on their own business). During design the assumption was made that the use of an API will offer the required flexibility for a generative platform on the non-hospitality sides of the platform. In

that sense G5 absolutely influenced the design, however actual usefulness of this guideline cannot be tested until other sides are added to the platform.

Vision & business model guidelines

Guidelines G2 and G6 both consider building a clear and coherent vision to deal with environmental complexity and build a reputation as neutral industry broker. These guidelines absolutely informed the design of the artifact, but the result is not as straightforward as expected. Building a vision and business model is an iterative process that depends on the environment as least as much as it influences it. Because of this, vision and business model should be continuously reassessed as development of the platform continues. The guidelines are useful in reminding the designer to do so, but is should not be expected that they immediately deliver a clear-cut product. Especially in the nascent stage of platform development it is not completely clear which parties are willing, and able to pay for usage of (parts of) the platform, and it can therefor be expected that pivots must be made when it comes to development of the vision and business model.

Nascent stage development

The strategies of G8 proved impossible to execute during this stage of platform development. It was not possible to gain sufficient trust from foodservice suppliers, and because of this tipping proved impossible as well. The coring strategy, development of a platform in a market where no platform exists, might be possible. It is currently expected that hospitality entrepreneurs will use the Checkmetrix platform. This does mean that a hub & spoke platform might already be a bridge too far and potential platform providers should first focus on a single side of the market before growing into a platform. This means that G8 is not useful in this stage of platform development. Instead a new guideline (G9) that focuses on the inception phase is suggested.

Guideline 9: Platform startups in markets where one side of the market is a large enterprise should focus on development of a value-creating product for a side of the market with small players, in order to reduce complexity, level the playing field with potential platform participants, and attain critical mass before connecting larger participants.

Discussion

This final section discusses the results of the research in three steps. First of all the scientific contribution is presented in the next paragraph. Secondly the generalizability of the findings is discussed, and finally limitations of the research and recommendations for future work are presented.

Scientific contribution

The main contribution of this research to literature is the elicitation, validation and development of the following six principles that can inform the design of a digital MSP for a start-up company.

1. Create clear vision and business model that balances pricing strategy, portfolio growth and user attraction, in order to deal with complex environments
2. Components of digital platforms must be loosely coupled through standardized interfaces, in order to reduce system complexity.
3. Layers must be coupled through standards and protocols shared by heterogeneous firms, in order to increase connectivity between platform participants.
4. Build a coherent vision of what the platform and its ecosystem should look like, to help build a reputation as neutral industry broker
5. Build strong partnerships with partners who share the platform vision, in order to reduce risk and increase power for the platform owner
6. Platform startups in markets where one side of the market is a large enterprise should focus on development of a value-creating product for a side of the market with small players, in order to reduce complexity, level the playing field with potential platform participants, and attain critical mass before connecting larger participants.

Besides the development of six design principles two other main contributions can be extracted from this research. First of all this research empirically confirms the idea presented in Gawer & Cusumano (2008) that start-ups are likely to have a harder time negotiating with large enterprise customers. Although this idea seems logical, this researcher has no knowledge of it being shown in practice. Interviews with foodservice industry suppliers specifically show that those enterprises have no interest in doing business with small start-ups, but are willing to cooperate once the platform matures.

Secondly, because this research shows that large enterprises (at least in the Dutch foodservice industry) are not willing to cooperate with early stage start-ups the process model of MSP development by Tan et al. (2015) does not hold under the condition that one of the two parties on the platform in the nascent stage is a large enterprise. To deal with this issue it is proposed to extend the process model of MSP development with an extra stage, the inception or product stage. Enacting MSP development of this stage will be a single sided platform or product.

Generalizability

A key element in the findings of this research is that the developed guidelines seem to hold for development of the platform for the hospitality side, but not for the foodservice side of the platform. The explanation for this is that the problem owner does not yet offer enough benefit to large corporate suppliers in the foodservice industry. This means the design principles are generalizable to the design of platforms where the platform owner's size is at least the same order of magnitude in size as the other parties involved.

Furthermore there are two other main issues with respect to the generalizability of this research. First of all the research has been performed only on a single case. Secondly the research has only been performed during the very earliest stage of development. Continuing this research will allow to identify if the extracted knowledge is also useful in later stages of development, or if it can be used as a basis to reach those later stages at all.

It is expected that the knowledge developed during this research is especially useful for the design of early stage platforms. More specifically the design principles for such an early-stage platform are useful when the purpose of the platform is to enable interaction between small parties in a fragmented market, and large enterprise parties.

Limitations & future work

Although meetings conducted with suppliers during this research show promising possibilities to connect foodservice suppliers to the Checkmetrix platform this intention can only be validated once the product is rolled out in the hospitality industry. This means the strategy of developing a platform by first creating a hospitality industry product can only be validated if development of the platform is monitored in later stages as well.

Because the process model of MSP development by Tan et al. (2015) takes an IS capability perspective on MSP development it is important to research the Checkmetrix case from an IS capability perspective as well. This is needed to fully extend the model with knowledge on the specific IS capabilities for the newly added inception stage, so that it is in line with the rest of the model.

Finally, although the foodservice industry seems to be the most promising business case from the perspective of Checkmetrix the company is also looking to deploy the Printerbox in different markets. An example of this is the fashion industry. In at least one of those markets Checkmetrix was able to secure a pilot with ING, a large international bank. This means that it must be further researched to what extent the idea that start-ups can hardly negotiate with large enterprises can be extended to outside the Dutch foodservice industry.

References List

AMRO, A. (2012). *Trends en ontwikkelingen*.

Bakos, Y., & Katsamakas, E. (2008). Design and Ownership of Two-Sided Networks: Implications for Internet Platforms. *Journal of Management Information Systems*, *25*(2), 171–202. http://doi.org/10.2753/MIS0742-1222250208

Baldwin, C., & Clark, K. (2000). *Design rules: the power of modularity*. MIT Press.

Baldwin, C. Y., & Woodard, C. J. (2008). The Architecture of Platforms: A Unified View. *Working Papers -- Harvard Business School Division of Research*, 1–31. http://doi.org/10.2139/ssrn.1265155

Boudreau, K. J., & Hagiu, A. (2009). Platform Rules: Multi-Sided Platforms as Regulators. *Working Papers* --

Harvard Business School Division of Research, 1–29. http://doi.org/10.2139/ssrn.1269966

CennamO, C., & Santalo, J. (2013). Platform competition: strategic trade-offs in platform markets. *Strategic Management Journal*, *1350*(February 2012), 12. http://doi.org/10.1002/smj

Corporation, I. (2013). Intel® - Based Point-of-Sale Solutions Market Segment Overview. Retrieved from http://www.intel.com/content/dam/www/public/us/en/documents/solution-briefs/point-of-sale-market-segment-overview-brief.pdf

Delta loyd. (2014). *Brancherapport Horeca*.

Eisenmann, T., Parker, G., & Alstyne, M. W. Van. (2006). Strategies for Two- Sided Markets. *Harvard Business Review*, *84*(10), 12. http://doi.org/10.1007/s00199-006-0114-6

Evans, D. S., & Schmalensee, R. (2010). Failure to Launch: Critical Mass in Platform Businesses. *Review of Network Economics*, *9*(4). http://doi.org/10.2202/1446-9022.1256

Gawer, A., & Cusumano, M. A. (2008). How companies become platform leaders. *MIT/Sloan Management Review*, *49*(2). http://doi.org/Article

Gawer, A., & Cusumano, M. A. (2014). Industry platforms and ecosystem innovation. *Journal of Product Innovation Management*, *31*(3), 417–433. http://doi.org/10.1111/jpim.12105

GfK. (2015). Retail Trend Monitor 2013, (April), 1–13.

Gregor, S., & Hevner, A. R. (2013). POSITIONING AND PRESENTING DESIGN SCIENCE Types of Knowledge in Design Science Research. *MIS Quarterly*, *37*(2), 337–355.

Hagiu, A. (2006). Multi-Sided Platforms: From Microfoundations to Design and Expansion Strategies. *Business*, 1–25. http://doi.org/10.2139/ssrn.955584

Henfridsson, O., Mathiassen, L., & Svahn, F. (2014). Managing technological change in the digital age: The role of architectural frames. *Journal of Information Technology*, *29*(1), 27–43. http://doi.org/10.1057/jit.2013.30

Het aanbod van kassasystemen | Checkout. (2015). Retrieved April 13, 2016, from http://www.checkout.nl/trends-en-ontwikkelingen/marktaandelen

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design Science in Information Systems Research. *MIS Quarterly*, *28*(1), 75–105. http://doi.org/10.2307/25148625

Holzer, A., & Ondrus, J. (2011). Mobile application market: A developer's perspective. *Telematics and Informatics*, *28*(1), 22–31. http://doi.org/10.1016/j.tele.2010.05.006

Iansiti, M., & Levien, R. (2004). Strategy as Ecology. *Harvard Business Review*. Retrieved from http://www.jstor.org/stable/4135159

Kallinikos, J., Aaltonen, & Marton, A. (2013). The ambivalent ontology of digital artifacts. *MIS Quarterly*, *37*(2), 357–370.

Katz, M., & Shapiro, C. (1985). Network Externalities, Competition, and Compatibility, *75*(3), 424–440.

Nikayin, F. (2014). *Common Platform Dilemmas: Collective Action and the Internet of Things*. http://doi.org/10.4233/uuid:ff561d27-4f2e-4d7f-8245-6b86dbb50e10

Parker, G. G., & Van Alstyne, M. W. (2005). Two-Sided Network Effects: A Theory of Information Product Design. *Management Science*, *51*(10), 1494–1504. http://doi.org/10.1287/mnsc.1050.0400

Rabobank. (2015a). Rabobank Cijfers & Trends Horeca recreatie. *Rabobank Cijfers & Trends*, (april), 1–5.

Rabobank. (2015b). *Rabobank Cijfers & Trends Voedingsmiddelenindustrie*. *Rabobank Cijfers & Trends*.

Rabobank. (2016). Rabobank Cijfers en Trends Horeca & Catering, 1–3.

Reuver, M. De, Sorensen, C., & Basole, R. C. (2016). The Digital Platform. *Unpublished - Draft Under Review*, 1–15.

Rochet, J., & Tirole, J. (2006). Two-sided markets: a progress report. *The RAND Journal of Economics*, *37*(3), 645–667. http://doi.org/10.1111/j.1756-2171.2006.tb00036.x

Schilling, M. A. (2000). Towards a general modular systems theory and its application to inter-firm product modularity. *Academy of Management Conference*. http://doi.org/10.3386/w19846

Sligro. (2015). *Jaarverslag 2015* (Vol. 53).

Tan, B., Lu, X., Pan, S., & Huang, L. (2015). The Role of IS Capabilities in the Development of Multi-Sided Platforms: The Digital Ecosystem Strategy of Alibaba.com. *Journal of the Association for Information Systems*, *16*(4), 248–280.

Tilson, D., Lyytinen, K., & Sørensen, C. (2010). Digital infrastructures: The missing IS research agenda. *Information Systems Research*, *21*(4), 748–759. http://doi.org/10.1287/isre.1100.0318

Tiwana, A. (2013). *Platform Ecosystems: Aligning Architecture, Governance, and Strategy* (Vol. 12). Newnes. Retrieved from https://books.google.com/books?hl=en&lr=&id=IYDhAAAAQBAJ&pgis=1

Vaishnavi, V., & Kuechler, B. (2004). Design Science Research in Information Systems Overview of Design Science Research. *Ais*, 45. http://doi.org/10.1007/978-1-4419-5653-8

Verschuren, P., & Hartog, R. (2005). Evaluation in Design-Oriented Research. *Quality & Quantity*, *39*(6), 733–762. http://doi.org/10.1007/s11135-005-3150-6

Yoo, Y., Henfridsson, O., & Lyytinen, K. (2010). Research Commentary —The New Organizing Logic of Digital Innovation: An Agenda for Information Systems Research. *Information Systems Research*, *21*(4), 724–735. http://doi.org/10.1287/isre.1100.0322