

Value Creation in the Cloud: Understanding Business Model Factors Affecting Value of Cloud Computing

Completed Research Paper

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ABSTRACT

Despite the rapid emergence of cloud technology, its prevalence and accessibility to all types of organizations and its potential to predominantly shift competitive landscapes by providing a new platform for creating and delivering business value, empirical research on the business value of cloud computing, and in particular how service providers create value for their customers, is quite limited. Of what little research exists to date, most focuses on technical issues. This paper aims to address this research gap by exploring how cloud technologies are used to create business value and identifying factors that may impact the realization of business value. Drawing on four case studies that considers the perspective of both service provider and customer, this study takes a more comprehensive perspective of the business model concept in examining business value than has been done to date in the cloud domain, thus contributing to the limited literature surrounding the area.

Keywords

Cloud Computing, Business Model, Value Creation

INTRODUCTION

Research has argued that cloud computing has the power to predominantly shift competitive landscapes by providing not just a new platform for creating and delivering business value, but “breaking up traditional value chains and making room for new business models” (Leimeister et al. 2010). Many providers like Amazon, Google, IBM, Microsoft, Salesforce, and Sun have already positioned themselves as platform and infrastructure providers in the cloud computing market. Beside them, there emerge more and more providers, who build their own applications or consulting services upon infrastructure services offered by other market players (Leimeister et al. 2010).

Six patterns of benefits that companies achieve from leveraging cloud computing capabilities have been identified by Iyer and Henderson (2012) in their field study of seven early adopter companies. Such benefits include collective problem-solving, increased business focus and business model experimentation. Nonetheless, despite the rapid emergence of cloud computing, empirical research on the business value of cloud computing is quite limited (Iyer and Henderson, 2012, 2010; Khajeh-Hosseini et al. 2010; Leimeister et al. 2010), with most of it focusing on technical related issues. The literature to date has neither utilized existing conceptual frameworks that better explain how service providers (SPs) create value with cloud computing, nor has it clearly articulated the central issues related to this phenomenon. Our study strives to fill this gap by examining business value in a manner that takes more complete consideration of the business model concept than has been done to date in the cloud domain. Thus, the objectives of this study are to (i) explore the means by which cloud technology is used to create business value, and (ii) identify factors that may impact the realization of these means of business value.

The next sections of the paper describe the theoretical background and framework to guide the study. The research approach adopted in this study is then outlined and findings and analysis presented. The paper concludes with a discussion of the implications of the study, along with some directions for future research.

THEORETICAL BACKGROUND

Traditional Approaches to Value Creation

Theoretical frameworks, e.g. transaction cost economics (TCE) theory and Porter’s (1985) value chain analysis, have been used to review value creation in general. Porter’s value chain framework is considered the accepted language for analyzing value creation at the firm level and addresses the activities a firm should perform and how and what the configuration is of the firm’s activities that would enable it to add value to the product and to compete in its industry. However, Stabell and

Fjeldstad (1998) found this type of framework more suitable to describing and understanding value creation in a traditional production and manufacturing company and less so in service industries where the resulting chain does not fully capture the real meaning of value creation. Similarly, Prahalad and Ramaswamy (2002) argue that the logic of the value chain is underpinned by a company-centric view (i.e., outside the firms' boundaries, only markets exist), something that is at odds with the cloud phenomenon, as it is evident from the existing literature (e.g. Iyer and Henderson 2012; Leimeister et al. 2010) that firms collaborate with various stakeholders such as suppliers, intermediaries and/or customers to improve their internal capabilities or expand the market for external use of their respective cloud offerings. Another theory of the firm that makes important suggestions about value creation is transaction cost economics (TCE). Ronald Coase first introduced the concept of transaction costs in his article, the Nature of the Firm in the late 1930s. Transaction cost economics is essentially a single company oriented analysis of cost minimization where transaction efficiency is identified as a major source of value, i.e., enhanced efficiency reduces costs. However, one of the limitations of the TCE theory is its stringent focus on transactions and the view of the boundaries between market and hierarchy (Rajala and Westerlund 2005). In addition, TCE theory focuses on cost minimization and neglects innovation (Lazonick 1993) and the mutual relationship between exchange parties and the opportunities for value creation that this presents (Amit and Zott 2001).

Overall, the value chain analysis and transaction cost economics are incomplete mechanisms for analyzing value creation in the cloud since they neglect the importance of complementors in an ecosystem or network, something deemed extremely important in the cloud computing context. For instance, Leimeister et al. (2010) suggests that with cloud computing, the traditional value chain becomes more complex and breaks up into a multitude of different actors and their interactions to depict a network rather than a sequential chain. Given that many of the traditional methods for analyzing value creation are not suitable for understanding the business value of cloud computing, we argue that a business model lens offers a more effective lens to better explore this area.

Business Model Ontology

Osterwalder et al. (2005) define a business model as “the rationale of how an organization creates, delivers and captures value”. Creating value necessitates identifying a relevant customer segment, the value proposition for those customers, and the ways in which the business model will provide that value (West, 2007; Morris et al. 2005; Chesbrough and Rosenbloom 2002). Additionally, Shafer et al. (2005) agree that value creation is a core element of a business model and argue that successful firms create and deliver substantial value by doing things that differentiate them from the competition. They might develop core competencies, capabilities etc. that are different from competitors and use these to perform work activities in a unique way. Several researchers have explored what might be included in a business model and have decomposed business models into components. For example, Alt and Zimmermann (2001) specify the following components of the business model: 1) customer value, 2) scope, 3) pricing, 4) revenue source, 5) connected activities, 6) implementation, 7) capabilities and 8) sustainability. In a similar vein, Chesbrough and Rosenbloom (2002) present a basic framework describing the business model as having six elements: 1) value proposition, 2) market segment, 3) value chain structure, 4) revenue generation and margins, 5) position in value network and 6) competitive strategy.

Osterwalder et al. (2005) also investigated what elements were used in business model research and propose a meticulous ontology that focuses on nine building blocks that make up a business model (see Table 1). These elements can be seen as common elements that capture the main features of the components listed above. This ontology builds on and integrates ideas advocated by Porter's value chain analysis, by concentrating on the importance of configuring activities and processes for value creation. It also builds on the theory of TCE as it looks at the relationship between participants in the business venture, focusing on aspects such as the transactional elements involved in the interaction between firm and client. However, one important building block that is embedded in this ontology is that of a partner network, an element that is lacking in traditional theoretical approaches and something that we believe is extremely important in the cloud computing context.

Business Model Pillar		Description
Product	Value Proposition	Gives an overall view of a company's bundle of services and products
Customer Relationship	Target Customer	Describes the segment of customers the company wants to offer value to
	Distribution Channel	Describes the various means of the company to get in touch with its customers
	Relationship	Explains the kind of links a company establishes between itself and its different customers segments
Infrastructure Management	Value Configuration	Describe the arrangement of activities and resources (tangible, intangible and human assets)
	Core Competency	Outlines the competencies necessary to execute the company's infrastructure business model
	Partner Network	Portrays the network of cooperative agreements with other companies necessary to

		efficiently offer and commercialize value
Financial Aspects	Cost Structure	Sums up the monetary consequences of the means employed in the business model
	Revenue Model	Describes the way a company makes money through a variety of revenue flows

Table 1: Nine Business Model Building Blocks (Source: Osterwalder et al. 2005)

RESEARCH METHOD

Case Selection

To effectively address the objectives of this study, four cases were purposefully selected based on a number of criteria, namely (i) companies whose cloud initiative(s) were part of their core business, (ii) companies whose cloud initiative is complementary to their core offering, (iii) companies whose cloud initiatives were interesting or highly contemporary, therefore suiting an exploratory study such as this, and finally (iv) ease of access to data from both suppliers and customers/users of the cloud technology. Our research method involves four case studies representing cloud vendors/service providers (SourceDogg, AD Network*, Rimal* and InnoCloud¹) and their respective customers (see Table 2).

<i>Firm</i>	<i>Industry</i>	<i>Cloud Initiative</i>	<i>Interviewees</i>
Case Study I - SourceDogg (Software as a Service)			
SourceDogg	Procurement software	The company's cloud-based e-sourcing service allows users to find and evaluate new suppliers	CEO (1 interview) Executive Director (2 interviews) CTO (1 interview) IT Manager (1 interview)
IBTB*	Public Sector Body (Health)	The company has adopted SourceDogg.com e-sourcing system in their procurement environment.	Purchasing Manager (1 interview)
APM*	Public Sector Body (Food and Drink)	The company has adopted the e-sourcing system in their procurement environment.	Procurement Officer (1 interview)
Case Study II - AD Network (Infrastructure as a Service)			
AD Network*	IT and Networking Solutions	Provides businesses with a modular IT infrastructure, covering networking; network traffic and security; storage, etc.	CTO (1 interview)
Information Mosaic	Global Securities Processing	Leverage AD Network's cloud infrastructure service in their development environment.	Product Management (2 interviews) IT Manager (1 interview)
Case Study III - Rimal (Software as a Service)			
Rimal	Consultancy	RimalLive suite of management system on-line tools includes Continuous Improvement, Training, Asset Management and Documentation control	Managing Director (2 interviews) Developer (2 interviews)
NDC*	Electronics	The company use the RimalLive continuous improvement tools to manage their ISO systems	IT Manager (1 interview)
Case Study IV - InnoCloud (iSaaS)			
InnoCloud	IT Infrastructure and Consultancy Services	Supplies hybrid, public and private cloud infrastructure hosting and provides end-to-end software services in the form of virtual desktops, hosted dynamics CRM, etc.	Technical Director (2 interviews) Sales Director (2 interviews)
TarPro*	Smartphone Application Development	Use all aspects of the cloud such as Virtual Desktops, Microsoft Exchange, Microsoft Office Suite and data storage	Finance Officer (1 interview)

Table 2: Data Sources for the Study

Data Collection and Analysis

Data collection took place between October 2011 and July 2012 and was primarily personal face-to-face interviews, a technique that allows expansive discussions to illuminate factors of importance (Oppenheim 1992; Yin 2003) and so is well

¹ AD Network, Rimal, InnoCloud, IBTB, APM, NDC and TarPro are pseudonyms used to protect anonymity.

suited to exploratory research such as this. The interviews lasted between 50 and 100 minutes and questions were largely open-ended, allowing respondents freedom to convey their experiences and views, and expression of the socially complex contexts that underpin value creation in the cloud (Oppenheim 1992; Yin 2003). An interview protocol for service providers was prepared based on all elements of the business model framework discussed in Table 1. For customers of providers, our interview protocol varied slightly in that we focused only on certain elements of the business model framework such as their perception of the value proposition, their relationship with providers and the partner network. Additionally, we asked questions around perceived challenges to business value with cloud computing. In order to aid analysis of the data after the interviews, all were recorded with each interviewee's consent, and were subsequently transcribed, proof-read and annotated by the researcher, and then coded using nVivo. Supplementary documentation relating to the cloud technologies and their use were also collected. These included a comprehensive review of publicly available documents including websites of firms, company brochures, white papers etc. Also, venting was used, whereby results and interpretations are discussed with professional colleagues to avoid the problem of what Kaplan and Duchon (1988) call multiple realities.

Data analysis was undertaken using coding techniques, i.e. open and axial, proposed by Grounded Theorists, Strauss and Corbin (1990). However the study did not utilise the Grounded Theory method of analysis – rather just the coding techniques. This form of analysis facilitates the development of substantive theory without prior hypotheses and can be utilised in the absence of, or in conjunction with, existing theory (Strauss and Corbin 1990). In the initial phase, 'open coding' was used to determine the main ideas in each transcript. These ideas were then grouped by significant headings (informed by the items in Tables 1) to reveal categories and sub-categories. The second phase of analysis used axial coding. Axial coding is defined by Strauss and Corbin (1990) as a set of procedures whereby data are put back together in new ways after open coding; whereas open coding fractures the data into categories, axial coding puts the data back together by making connections between the categories and sub-categories. As categories emerged follow-up interviews were arranged with all of the original interviewees to elicit further, richer, more focused information. As categories became integrated, further data collection did not tend to cause any additional categories to emerge, but rather reinforced those already in existence. At this point, the categories were deemed to be 'theoretically saturated' (Strauss and Corbin 1990), and data collection ended.

FINDINGS AND ANALYSIS

Product

Value propositions of SPs that deliver software as a service (e.g. SourceDogg, Rimal, InnoCloud) include the provision of transparent and auditable systems that facilitate better communication and enable companies to save money, time and improve their business processes. Both managers at InnoCloud described how their value proposition was quite unique from other competitors in that they provide end-to-end services from initial audits that assess customer 'viability for the cloud', as well as the actual migration to the cloud, disaster recovery plans and professional consultancy services. They further elaborated that their cloud computing services enable companies to reduce IT costs, while increasing security, efficiency and scalability. The CEO in Rimal also pointed out that their system gives clients a standardized way of managing their quality systems. He further pointed out that, "because we can standardize the implementation, this allows us to spend less time on repeating work that we would have done in the past with other clients, and gives us more time to actually concentrate on core values". For AD Network who deliver infrastructure as a service, the value proposition is the provision of a scalable, flexible IT infrastructure that enables customers to reduce costs with round-the-clock support expertise. The CTO at AD Network explained that the move away from the capital expenditure intensive model to the operating expenditure one has resulted in lower infrastructural costs for clients.

In terms of customers perception of the various value propositions listed above, managers in APM and IBTB explained that with the continuing economic challenges, organizations are faced with an increased pressure to seek cost savings in their procurement process. With the SourceDogg system, both of these companies experienced cost savings of up to 20%. Similarly, both managers at Information Mosaic explained that they had gone through a large growth pattern in the last year and through AD Network's offering, were able to continually absorb the increased demand on resources.

There are some challenges for SPs, however, in facilitating effective value propositions around cloud offerings. For SourceDogg, one challenge includes difficulties in integrating their system with other IT systems. However, this company is not aiming to integrate directly with other IT systems, e.g. ERP systems. The Executive Director explained that, "the problem is, if you get into integration, then you go away from what your core offering is, which is to get clients up and running quickly". Both managers at SourceDogg believed there was tremendous creativity and innovation in their product. However, in terms of delivery, "you have to be a bit more locked down in how you deliver it because if you want to scale to 100 or 300 people, you have to have a process to say, right, this is how are we doing something. So there's lots of creativity that goes into getting to that process and there's lots of continuous improvement to get to refine that process". Similarly, the CEO at Rimal explained that they are constantly trying to refine their cloud system in terms of user-friendliness and intuitiveness. This manager revealed that he would like the system to "be more intuitive and more user friendly so that it feels like an Apple product. You know you very seldom need to look up a manual for an app. So that's where I would like it

to be in the longer term”. The Project Manager at NDC (a customer of Rimal) also agreed that while the underlying workflow engines of RimalLive are quite rigorous, the system requires more work in terms of user-related features.

Customer Relationship

Target customers for service providers include both public and private bodies. For example, since launching in 2010 SourceDogg has built up clients in sectors ranging from healthcare, hospitality and entertainment to manufacturing, retail, services and transportation in five different countries. Additionally, the managers at InnoCloud explained that they target private sector companies consisting of ten to fifty users. The Sales Director in InnoCloud described how their niche customer base consists mainly of companies that work internationally – “we have a company that is headquartered in Dublin and works out of the USA, Kazakhstan and Saudi Arabia. But because we have our data centres in Germany, on the European backbone, in terms of latency, this means that rather than going through seven or eight different routers, this company is only going through one or two points or routers, and they can get their information across to Dublin seamlessly” (Sales Director, InnoCloud). *Distribution channels* include web marketing, email marketing, word-of-mouth etc. Nonetheless, the Executive Director at SourceDogg explained that while email marketing and word-of-mouth has served the company well in the UK and Ireland, to go global they need to engage in marketing methods such as search engine optimization and “we need to have a web demo team who work on people who look at demos. And then we need a lead generation team who phones up companies and talks them through the system and asks ‘are you interested’...So it’s a combination of all of those and then field sales as well”. All of the SPs also agreed that once signing up with new companies, they get further exposure to a lot of potential new customers. However, both managers at InnoCloud pointed out that in order to sustain competitive advantage, it’s imperative to keep marketing the brand and getting their name ‘out there’ and keeping it going. Nonetheless, most of the SPs in the study pointed out that people’s perceptions of the term ‘cloud’ often poses a challenge for SP offerings. As the CEO in Rimal pointed out, “you know sometimes you would wonder if the word ‘cloud’ hadn’t been around, would we be better off”. Several other study participants (e.g. InnoCloud, AD Network) believed that while the term became fashionable rapidly, it became tainted just as quickly. As a result, when marketing to new customers, these companies purposely tend not to talk about ‘cloud’ per se, but rather a new service delivery model.

In terms of the *relationship* with customers, all of the service providers in the study believe they take a service centric approach in the way they engage and work with customers. Additionally InnoCloud provide out of office hours support which the Finance Officer at TarPro believed was extremely valuable. All of the SPs explained that they have a close, trustworthy relationship with clients, in that they take feedback on board and provide support and mentoring capabilities if needed. For example, the CTO at AD Network revealed that “we don’t only want to work with the customer, we are also interested in having open conversations about how we would help them build new revenue streams....you know, a proper partnership. That is something that I think has value, and I think will carry us into the future”.

Nonetheless, as security and privacy are two aspects that some customers worry about, this can be significantly challenging for SPs. For example, the managers at InnoCloud explained that it is often difficult to sell the idea of cloud computing to certain clients, as managers in these companies like to “see a physical box (server) that makes noise in the office, so that if something goes wrong, they can grab the box and run out the door! So the idea of going virtual doesn’t sit easily with them – it’s a loss of control”. These managers pointed out that they see a younger demography taking up a lot more of their services. The study participants in Information Mosaic explained that with the AD Network offering they feel safe in the knowledge that they are aware of where their datacentres are actually hosted, as well as the legislation around the jurisdiction in which they are hosted. Nevertheless, all of the SPs in the study believed they had ‘locked-down processes’ on data confidentiality, with information repositories outsourced to a secure datacenter, which enables trust and customer loyalty.

Infrastructure Management

In relation to *value configuration*, SPs in the study possess a broad range of technical, business and service capabilities. As the CTO in AD Network explained “you have got to have the right mix of technical components, commercial components and service components. So within our organization, we have all three”. This manager further elaborated that SPs need to understand what the customer is trying to achieve. This may involve observing the customer in the field, in relation to how they do business today. Then it is a matter of getting the sales people, technical people, finance people etc. together in a group to try and solve the particular business issues that customers may have. Additionally, the managers at InnoCloud pointed out that their main asset is the IT knowledge base, which they built up themselves from scratch through VMWare Microsoft and the skills-set of the various employees in the firm. The study also found that brand recognition and reputation with clients were considered *core competencies* for all the service providers. However, the CEO in Rimal explained that while the majority of their clients use their cloud system, there are often difficulties in gaining some IT managers’ acceptance and approval of it. As this manager further elaborated “our system has been blocked by IT in some companies for the wrong

reasons. We could justify everything that they wanted the system to do but it was pointless”. Similarly the Technical Director at InnoCloud added that ‘it’s a tricky business – IT managers see us as a threat to their livelihood”.

For all of the SPs in the study, the biggest value is the *network* of different organizations they are part of. The Executive Director at SourceDogg explained that, “as an organization, you get to build up a massive network of buyers and suppliers, so we get to deal with an awful lot of different organizations”. The CEO further pointed out that, “we can capture information from our network, that we can mine and at a later stage, provide back analytic dashboards for people that assist them in benchmarking across the industry for buying certain things”. The CTO in AD Network described the partnerships they have with EMC and VMWare at Cisco while the remaining SPs discussed the networking arrangements they have with universities and research institutes. Presently, SourceDogg and Rimal are members of a research project focused on cloud research and frequently participant in forums and conferences around cloud computing. Both managers at SourceDogg believed that providing guest lectures to university students also serves as a recruitment vehicle in that they can target students from engineering and business information system disciplines that may be interested in working for the company. Moreover, customers in both IBTB and APM explained that implementing the SourceDogg system improved communication and networking inside their own respective organizations. The believed the systems gave employees ‘a sense of belonging’ and they felt more engaged as a result of ‘knowing what was going on’.

Financial Aspects

Regarding *cost structure*, all of the SPs explained that the biggest cost to their business are the employees who operate and manage the cloud offering. Both managers at SourceDogg explained that services costs are recovered by service charges while other costs are recovered by sales of software licenses. However, the CEO at Rimal explained that ideally they would like to recruit several more developers to work on RimalLive and move it forward. Nonetheless, this is difficult for small enterprises that lack the funding. Thus, this manager further explained that access to Irish or EU funding is important in order to become an international company and hire people to work on various elements of the system. Additionally, the Technical Director at InnoCloud explained that while it cost them an extraordinary amount of money to get everything up and running, the biggest cost to their business now is man-hours and labour. Often, customers will call out their IT experts if they have problems with migration, sometimes out of office hours. However, this manager pointed out that these extra hours are often not quantifiable and what one finds is that “the customer might argue that these additional hours are included in the SLA and you may have to argue that it’s not” (Technical Director, InnoCloud).

The *revenue model* of SPs consists of a pay-per use model either monthly or yearly. For example, AD Network’s infrastructure service puts clients in control of flexible computing environments that are hosted in a secure AD Network datacenter and provided on a monthly subscription basis. However, Rimal presently make no money with their cloud offering as it is presently a complimentary offering. The CEO further explained that they want to make their system more of a professional, collaborative tool before charging customers for it. Moreover, the company is working with clients to try and improve the system. Going forward, however, Rimal would like to start charging for the system - “we hope to build up a more licensed business going forward...or a franchise business even. This will allow us to expand internationally. And there will also be opportunities for us to sell it to other consultancy companies” (CEO, Rimal).

DISCUSSION AND CONCLUSION

The business model ontology proposed by Osterwalder et al. (2005) proved an effective lens to better understand the means by which cloud technology is used to create business value. The study revealed that each of the SPs in the study offer an attractive value proposition to their respective customers. Such customers are attracted to the agile, pay-as-you-use cloud business model insofar as this model allows them to manage their costs more efficiently and facilitates deployment of new technology faster. Additionally, SP relationships with their existing customers are extremely effective. However, to expand into new markets and attract a wider customer base, SPs may need to give some thought to multi-faceted marketing strategies such as social media, SEO profiling etc. All of the SPs sustain value appropriation from their cloud offering as a result of their core competencies, namely an excellent reputation with customers (due to the relationships they maintain with them). Nonetheless, as cloud computing becomes more mainstream, we believe that SPs offering a similar service need to develop unique competencies and distinctive capabilities that differentiate them from competitors in the cloud market and enable them to continue to attract and retain customers.

In terms of the factors that impact the realization of business value, SPs need to be aware that potential customer adoption of cloud systems represents a shift in organizational culture and norms as different skills and capabilities are required. Thus, SPs need to alleviate any fears IT managers may have around security and data confidentiality and provide some educational

awareness of regulations in various jurisdictions in which data centres are hosted. Most importantly, SPs need to assuage any feelings IT managers may have about ‘losing control’ of their IT environment.

In support of research from Iyer and Henderson (2012) and Leimester et al. (2010), the study also found a partner network to be of utmost importance for value creation. Most of the SPs collaborate with their customers, universities, research institutes and partner organizations. It can be suggested, however, that given restraints with personnel budgets and know-how, it may be wise for SPs, particularly start-ups, to consider their potential to access networks of complementors to promote visibility globally, develop their existing capabilities/skills-set and enhance their innovation and value creation potential. In terms of cost structure, all of the SPs indicated human resources as the biggest cost to the business. Nonetheless, there may be hidden costs that SPs in general may not fully understand, for example, they need to consider extra services such as support and training that are bundled in with their cloud offering and assess whether their existing revenue model is cost effective.

This study compliments existing research around cloud computing that concentrates either on technology issues or lack rigorous empirical data. To our knowledge, no research has utilized a business model framework in examining value creation with cloud computing. Moreover, employing the perspective of both SP and customers proved highly effective, as existing studies tend to focus on adopter companies. Overall, our findings suggest that SPs need to give more thought to how best they can employ cloud-enabled business models that promote more differentiation in terms of their offering and enable competitive advantage in the long term. Our research was exploratory and future research could delve into each of the business model pillars in more detail (i.e. product, customer relationship, infrastructure management and financial aspects). For example, one such pillar worthy of future research is the financial aspect of the business model, in particular assessing and evaluating return on investment. Additional research could also focus on how firms achieve dynamic capabilities and core competencies for sustainable competitive advantage in the cloud. One such theory from the strategic management literature that may prove useful in this regard is that of Dynamic Capabilities (see Teece et al. 1997). Future research could utilize this theory to better examine how service providers create value by developing new capabilities and competencies that enable them to create and sustain competitive advantages with cloud offerings. Finally, conducting research with service providers that have successfully leveraged networks of complementors around cloud may help companies (new to the cloud landscape) discern ways in which value can be realized from ecosystem participation.

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