A Metrics Suite for Firm-Level Cloud Computing Adoption Readiness

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Abstract. Recent research on cloud computing adoption indicates that there has been a lack of deep understanding of its benefits by managers and organizations. This has been an obstacle for adoption. We report on an initial design for a firm-level cloud computing readiness metrics suite. We propose categories and measures to form a set of metrics to measure adoption readiness and assess the required adjustments in strategy and management, technology and operations, and business policies. We reviewed the relevant interdisciplinary literature and interviewed industry professionals to ground our metrics based on theory and practice knowledge. We identified four relevant categories for firm-level adoption readiness: technological, organizational, economic and environmental factors. We defined sub-categories and measures for each category. We also proposed several propositions to show how the metrics can contribute to business value creation.

Keywords: Adoption Readiness, Cloud Computing, Firm-Level, Managerial Decision-Making, Metrics Suite.

"The agility of [the] cloud enables businesses to get products to market faster by joining up the different parts of the development chain. Sectors such as healthcare and financial services can connect customers and influencers … to assess market needs and quickly translate this into new ideas and … new products and services."

Rick Wright, Global Cloud Enablement Program Leader, KPMG, 2013

"It is not sufficient to consider only the potential value of moving to cloud services. Agencies should make risk-based decisions which carefully consider the readiness of commercial or government providers to fulfill their Federal needs. These can be wide-ranging, but likely will include: security requirements, service and marketplace characteristics, application readiness, government readiness, and program's stage ..."

Vivek Kundra [2011] CIO of the United States

1 Introduction

Cloud computing services offer new technological capabilities that support information technology (IT) services users and enterprise customers, by simplifying IT services acquisition, providing faster implementation, and offering flexibility for the economic consumption of powerful software applications, data management and infrastructure computing support. The U.S. National Institute of Standards and Technology [2013] defines *cloud computing* as "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider inter-

action." The economic impact of cloud computing is estimated to reach US$1.7 to US$6.2 trillion annually by 2025 [Manyika et al. 2013]. As the market develops, diverse and customized services will be available to satisfy sophisticated customers.

In 2012, *InformationWeek* published a commentary that motivated our research: "How should we measure clouds?" [Croll 2013]. The author noted: "[*We*] *need to … look at the business model. From there, we can derive the relevant metrics … That's a much more palpable approach to measurement for executives*." Our approach is different, less operational, and focused on adoption. Managers need to assess cloud computing for how it will support their businesses and create business value. This research emphasizes key issues that need to be addressed to assess what firms will adopt.

Our work is also motivated by the efforts made during the past three or four years by the Asia Cloud Computing Association (ACCA), a non-governmental organization representing the interests of stakeholders in the cloud ecosystem, whose mission is to expand the market in Asia. ACCA [2014] developed a "Cloud Readiness Index" to assess national penetration, for 14 countries in the region, with 10 measures. It categorized countries as "ever-ready leaders," "dedicated improvers," and "steady developers."

In this work, we will present a measurement approach and metrics suite to gauge the extent to which organizations are ready to adopt cloud computing. The metrics also help a firm to measure its adoption readiness and assess the extent that cloud computing will require adjustments to its strategy, management, IT and operations, and business policies. To develop the metrics suite, we ask these questions. (1) What are the major areas that concern business stakeholders the most during adoption decision-making? (2) What are the major facilitators and inhibitors? (3) What does the metrics suite need to consist of to be effective for senior management decision-making use?

Based on a literature review and interviews with industry practitioners, we identified four categories of factors that matter the most, characterize the contexts for clouding computing implementation and value creation well, and are supported by theory and past empirical research. They are: technology issues and cloud computing performance; economic and valuation issues; organizational and strategy issues; and regulation concerns and external business environment issues. These categories for measurement offer a basis for a fuller set of metrics, so it is possible to assess economic issues such as cost-benefit or vendor lock-in risks, or firm issues such as absorptive capacity and senior management support for technology innovation.

Section 2 gives an overview of the literature. Section 3 describes our metrics design approach, and presents our proposed metrics suite for firm-level cloud computing adoption readiness. Section 4 presents our answers to the research questions, and offers propositions about decision-makers' use of the metrics, business and strategy goals.

2 Background

To support the development of our metrics suite for cloud adoption readiness, we will begin by reviewing related literature on cloud computing adoption as well as the metrics suite approach.

2.1 Technology and Cloud Computing Adoption

There are two main streams of research on cloud computing adoption: theory-oriented works by information systems (IS) researchers, and practice-oriented solution-focused studies by software engineering management researchers.

Theory. The literature suggests key categories of variables that push forward or hold back IT adoption. For example, there are a number of works that focus on *technology factors*, such as technological innovations that made cloud computing possible [Armbrust et al. 2010], flexibility, infrastructure and standards [IBM 2009], architecture and systems design [Rimal et al. 2011], and information security [Anthens 2010].

Organization factors related to technology adoption are recognized too: the commitment of senior management [Oshri et al. 2010], service quality and partnerships [Grover et al. 1996], the extent to which the firm promotes technological innovation [Hirschheim et al. 2011], the firm's absorptive capacity for new IT projects and new technologies, and the IT governance process [Mani et al. 2006].

Economic factors represent another aspect of any explanatory or predictive approach to why firms push forward or hold back adoption. This category includes network effects and client installed base [Rodriguez 2012], lock-in disadvantage and standards [Marston et al. 2011], investment decision-making under uncertainty [Benaroch et al. 2010], value appropriation and return on investments [Alexander and Young 1996], ownership and information sharing [Kim and Moskowitz 2010], and pricing.

A final category is *environmental factors.* They include industry differences and standards [Qu et al. 2011], data privacy and information security [Breuning and Treacy 2009], vendor and technology competition [Ross and Blumenstein 2013], and perceptions in the financial markets [Oh et al. 2006].

Practice. There are two groups of practice-oriented studies. One explores the practical reasons for cloud computing adoption. These include the study of adoption and governance [Borgman et al. 2013], opportunities and return-on-investment versus the risks [Merrill and Kang 2014], facilitators versus obstacles [Habib et al. 2012], customer selection of cloud services and vendors, and unexpected market entrants and regulations. Through interviews and questionnaire surveys, various authors have reported critical areas of business practice that are related to cloud adoption decision-making. The other group of studies provides decision-making tools for managers related to technology and cloud adoption. They cover such areas as cost-benefit analysis, technology suitability and economic suitability analysis [Khajeh-Hosseini et al. 2012]. Other industry papers offer suggestions on architectural and IT governance principles for risk control [Cloud Security Alliance 2010;], information security [Wright 2004], and implementation effectiveness [Cisco 2014]. The reports contain technical details and are vendor-specific, but present the issues that practitioners face, and how cloud readiness metrics can help out.

Firm-level decision-makers can benefit from theory-based explanations of cloud computing adoption and performance, as well as actionable suggestions to help their technology and operations. They also identified the scope for cloud computing readiness. Survey research on IT outsourcing [Ang and Straub 1998] and business process outsourcing [Lacity et al. 2011] involves perceptual scales containing limited technical

or economic contents, and are intended to aid in the qualitative aspects of decision-making and strategic planning. Practice-oriented studies tend to focus on specific aspects, such as the technological suitability of cloud computing [The Open Group 2014] or migration guidance [Sutherland and Chetty 2014]. Even though they have technical or managerial details, they reflect aspects of cloud computing that are easily understood by senior IT managers and planners. Thus, measures that capture firm changes in cloud adoption readiness must incorporate the strengths and rigor of theory and relevance of practice.

2.2 Characteristics and Applications of Measures and Metrics Suite Approaches

Characteristics. Individual *measures* are useful to provide basic elements to assess performance in processes and systems, and how technologies will succeed in delivering value. When we bring together measures that represent different aspects of performance, we refer to them as a *metrics suite.* This term is used in engineering, software systems, and business process management contexts. Metrics suites have been used to capture and quantify complex aspects of operational processes, help managers to evaluate business performance, and enable them to make effective adjustments and achieve desirable outcomes. In addition, metrics suites have been used to create measurement approaches to capture quantitative and financial performance, and qualitative and intangible organizational capacities [Kaplan and Norton 1996], measure interdependent aspects of systems design in software development [Chidamber and Kemerer 1994], and simplify financial risks based on a set of numerical measures [Jorion 2000].

Managerial decision-making processes for cloud computing adoption and migration are complicated, and require carefully set targets and effective reviews. Moving to the cloud represents technological changes and also a business model shift for the enterprise. It involves technological, economic, strategic, and business concerns, and considerations about an organization's internal capabilities and its external environment. Senior managers need measures that provide information on this range of issues to evaluate the firm's readiness for cloud computing services. Metrics suites that are based on theory are especially relevant for implementation, since theory is a strong basis for understanding how performance and outcomes arise.

Applications. In *software engineering*, metrics suites have been developed to measure the productivity and quality of application designs based on software objects [Briand et al. 1999]. Chidamber and Kemerer's [1994] proposed a six-dimension model, including weighted methods per class, depth of inheritance tree, number of children, coupling between object classes, response for a class, and lack of cohesion in methods. These measures can be linked to economic outcomes, such as software productivity and rework effort, which facilitate project planning and control. Empirical evidence has shown that using such metrics in the initial design stage can save 42% of corrective costs and efforts, and substantially improve final product quality [El Emam et al. 2001].

In *strategic performance management*, researchers and practitioners have designed and developed various metrics to measure process performance and intangible capabilities [Edvinsson and Marlone 1997]. These traditionally were ignored by established cost accounting evaluation methods. The Harvard Business School's "Balanced Scorecard" by Kaplan and Norton [1996] is the most successful metrics suite in performance

management. It has been widely used to set management objectives or to plan development and decision-making of new strategic systems [Nørreklit 2000], with 60% of Fortune 1000 firms in the U.S. having experimented with it [Silk 1998]. It integrates quantitative financial outcome measures and non-financial qualitative performance drivers. It assumes there is a causal chain of relationships starting from measures of organizational learning and growth, to internal business processes, then to the customer perspective, and finally to financial performance.

In *financial and accounting risk management*, various metrics such as Stern Stewart's *economic value added* (EVA) and RiskMetrics' *value-at-risk* (VaR) help senior managers to evaluate financial risk and make better investment decisions. EVA is the difference between accounting earnings and the cost of capital used to generate the earnings [Stern et al. 1996]. As a metrics suite, it focuses on the measurement of profits that remain after the impacts of debt cost and equity capital on a profit from operations.

In financial risk management, VaR represents the worst expected loss over a given time horizon under normal market conditions at a given level of confidence. It assesses exposure for financial firms for multiple financial instruments, which can be aggregated to assess the firm's composite risk [Jorion 2000]. Managers use it to forecast losses that may accrue from shocks to their business. As a consequence, it is viewed as a forward-looking way to measure financial risk. VaR metrics have received wide recognition due to their impacts on financial practice across industries.

2.3 On Designing a Cloud Computing Readiness Metrics Suite

Our purpose is to present design ideas for a metrics suite for cloud computing readiness. We have done so with core principles for performance measurement systems design in mind [Dewangan and Godse 2014]. Innovation adoption performance metrics should have five characteristics: (1) a stakeholder value orientation; (2) an innovation process orientation; (3) cause-and-effect relationships; (4) multi-dimensional assessments; and (5) easy implementation by people.

Stakeholder value. In designing performance metrics suite, how to address the needs of multiple stakeholders has always been an essential issue [Jorion 2000, Kaplan and Norton 1996]. A *stakeholder* is an agent who initiates changes or is impacted by changes derived from a technological innovation [Bourne et al. 2000]. Cloud computing has the potential to generate beneficial stakeholder impacts, by transforming the use of IT services. Identifying its value as well as the obstacles with multiple stakeholders are fundamental in establishing useful measures for cloud readiness evaluation.

Innovation process. Cloud computing adoption will be like adopting a technological innovation which may or may not be perceived as being entirely ready. So a meaningful metrics suite in our context, as Dewangan and Godse [2014] remind us, must also have the built-in capacity to assess cloud computing in a way that technology innovations are assessed – prior to the time they are implemented.

Cause-and-effect relationships. A metrics suite must contain identifiable cause- and-effect relationships between the measures that are used and the business goals of the organization [Kaplan and Norton 1996, Stern et al. 1996]. Establishing causality will ensure strategy, operations, and technical adjustments can be made to improve cloud

readiness, so it will serve organizational goals better and result in more business value. A theoretical basis in the literature and through practitioner interviews helps in identifying useful causal links.

Multiple measurement categories. A metrics suite should represent a balanced view of what are under study: financial or non-financial measures, technical or non-technical measures, or internal or external factors. Multiple categories are meaningful, establishing a base for deep managerial insights. This is consistent with the current view of the IT services ecosystem and the cloud computing services context.

Easy implementation. An effective metrics suite must be easy for managers to implement. Cloud computing adoption readiness is complex though. Still, it is appropriate to limit the number of measures, and ensure they have a similar level of granularity. Industry reports and input from practitioners helped us to scope and select measures that are aligned with organizational needs [Edvinsson and Marlone 1997].

3 A Cloud Computing Adoption Readiness Metrics Suite

When designing the firm-level cloud computing adoption readiness metrics suite, it will be useful to bridge theory and practice, and guide managerial decision-making [Holmstrom et al. 2009, Mohrman et al. 2001]. First, we aim to address practical issues in contemporary cloud computing industry settings. This research agenda was developed based on our participation in industry roundtables and workshops hosted by the Asian Cloud Computing Association. Second, we have sought to give equal weight to industry informants as what we were able to learn from the academic literature. Third, we sought to surface practitioners' knowledge to help interpret and understand their views, so as to create an informational base for specifying our metric suite's adoption readiness measures [Nonaka 1994]. We communicated with cloud providers, enterprise users, and government planners for cloud computing.

We next present the metrics suite. We will lay out four different measurement categories: technology and performance; organization and strategy; economics and valuation; and regulation and external environment. We will then illustrate the metrics suite.

3.1 Technology and Performance

The first category of measures is *technology and performance*, which assesses whether the cloud computing solutions fit the firm's IT and systems. There are two measure sub-categories: self-assessments of compatibility and expected service quality. Managerial decision-makers have to assess technology suitability and understand the expected level of IT service quality to decide whether cloud computing is the right for their organizations [Armbrust et al. 2010]. This requires fit and compatibility assessment [Low et al. 2011], and information, system and service quality levels that are consistent with the firm's business and IT practices [DeLone and McLean 1992, Tornatzky and Klein 1982]. To proxy for compatibility, we selected network access and virtualization. Cloud computing needs high quality network access and virtualization for fast network access and minimal latency [Vouk 2008]. Experience with virtualization will reduce the costs for cloud migration [Jamshidi et al. 2013]. Security, scalability and availability also are

critical quality measures for organizations [Garg et al. 2013].

Cloud computing converts traditional IS, maintenance, and usage into simpler IT services. Service quality – the difference between what the vendor delivers and what the user expects – is critical to firm-level IS success [Pitt et al. 1995]. Prior research has addressed the benefits and risks from an IT perspective [Venters and Whitley 2012]. In the service quality sub-category, we include three critical measures of quality: security, availability and scalability [Benlian and Hess 2011]. Security risks include contractual loopholes, confidentiality, information security, and service outages. Customers expect high availability, the percentage of time a customer can access the service [Garg et al. 2013]. Another important aspect of cloud service quality is scalability, which measures customer needs to receive services that scale to demand [Venters and Whitley 2012].

3.2 Organization and Strategy

The second category is *organization and strategy*, which assesses whether cloud computing solutions match the firm's strategic orientation and organizational capabilities. The subcategories are self-assessments of these things. Companies with good organizational capabilities and a strategic orientation are more ready to benefit from cloud computing [Buyya et al. 2010]. Decision-makers need to recognize the potential impacts of cloud computing use, and prepare for political obstacles [Garrison et al. 2012]. In our interviews, some IT executives emphasized that, when moving to cloud services, organizations have to make adjustments in IT governance policy and operating models according to the criticality and sensitivity of their tasks and data. An organization with accumulated experience and managerial capacity will adjust more smoothly [Hsu et al. 2014]. The critical capabilities for cloud adoption include absorptive capacity and vendor management experience [Aral and Weill 2007]. We use scales for external and internal knowledge acquisition and dissemination to measure an organization's absorptive capacity [Liao et al. 2003], and contractual and relational governance to measure its vendor management capacity [Poppo and Zenger 2002].

Strategy-focused organizations can identify the business value of cloud computing, and match its innovative characteristics with their own internal business needs. For strategic orientation, our metrics suite includes three measures: executive support, innovation inclination, and perceived competitive advantage [Messerschmidt and Hinz 2013]. Executive support is critical for creating a supportive climate, with adequate resources and opportunities for cloud adoption [Low et al. 2011]. Innovation inclination affects intention to adopt new technologies [Barczak et al. 2007]. And perceptions of competitive advantage and business value will affect adoption too [Hsu et al. 2014].

3.3 Economics and Valuation

The third category is *economics and valuation*, which assesses the economic suitability and business value of cloud computing. The sub-categories include: service and market valuation, and vendor reputation. Decision-makers need to assess their suitability with an economic perspective. For valuation, we employ a set of measures on the preferred pricing mechanism, estimated cost reduction, and contract flexibility [Truong and Dustdar 2010]. When vendors decompose their services into small configurable units, enterprises need to gauge their total execution costs. Flexible contracts will allow cli-

ents to balance the trade-offs among cost, benefit, risk, time and resource requirements [Koehler et al. 2010, Li 2011]. For example, in the cost calculation for cloud services, operational and hidden costs for IT interoperability need be considered.

The maturity of the cloud market, and market demand and supply will affect the adoption readiness of a firm. Standards, transparency, and reliability for vendor performance are basic market stabilizers [Hauff et al. 2014, ISACA 2012,]. They help reduce uncertainty. A healthy cloud market will have alternative services and vendors [ISACA 2012]. Vendor stability, scale, and reputation are critical for estimating the risk involved in adoption [Pauley 2010]. We use three measures for the vendors: financial stability, and technical track records including process maturity and security breaches and outage news.

3.4 Regulation and Environment

The final category of the metrics suite is the *external business and regulatory environment constraints* that an enterprise faces, which require an organization's strategic responses. The external business environment creates pressure and obstacles for adopting IT innovations, and can shape the strategic responses of firms that are affected by it [Miles and Snow 1978]. According to Walker et al. [2003], the business environment can be viewed as follows: the stage of the relevant product life cycle; extent of market segmentation, competition, and industry concentration; and technological maturity and structure. DeSarbo et al. [2005] suggested three environmental uncertainties: market, competitive and technology. Cloud computing services vendors deliver shared IT resources and capabilities with strong network effects for their clients. Past experience with one vendor's cloud services can generate mimetic and normative pressure on the client's beliefs about adoption [Messerschmidt and Hinz 2013]. Thus, we include three business environment measures related to cloud adoption: technology environment uncertainty, pressure to mimic competitors, and normative pressure from alliances.

Regulation constraints constitute the other important environmental factor. Different countries have different legal and regulatory rules regarding data privacy, data sovereignty and how local laws apply to data governance. Many have laws requiring cloud providers to keep customer data and copyrighted material within national boundaries [Armbrust et al. 2010]. Such constraints are a bind in multinational business. In our metrics suite, we use new measures for perceived regulatory constraints and data sovereignty issues based on ISACA [2012] and Armbrust et al. [2010].

3.5 The Cloud Computing Readiness Metrics Suite

Our metrics suite for cloud computing adoption readiness is shown in Figure 1. The metrics categories are bold and underlined, and sub-categories are solid bullet points. Hollow bullet points mark the measures, when a category is not also a measure.

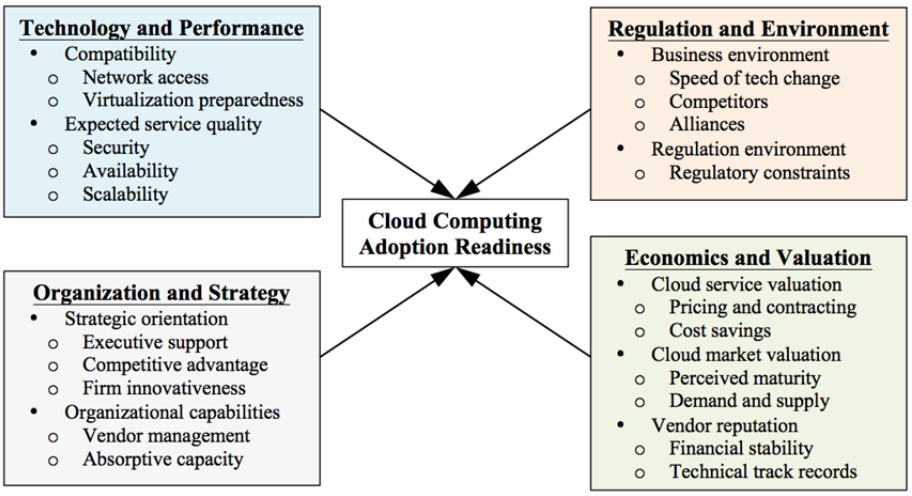

Figure 1. A Sketch of the Cloud Computing Adoption Readiness Metrics Suite

Appendix A offers more detailed coverage, as well as the identification of the proxy measures to capture information on the metrics sub-categories. They suggest our sensitivity to the cost and capacity issues for operating cloud services. We comment on the kinds and sources of the measures, and their development. Administration of a related questionnaire will elicit relevant data on adoption for assessment. Then, the information that is obtained can be leveraged to create organizational and technology strategies for adoption and implementation actions based on what the market is able to supply. When management is able to make informed choices to obtain the "right" solutions, they will be able to maximize the business value of cloud computing for the firm.

4 Implications for the Business Value of Cloud Computing

We conclude with thoughts about how the metrics suite can be used to create business value. It can be used to support pre-implementation assessment for migrating to cloud. Consulting firms can use it to establish industry adoption benchmarks. Regulators can apply it to investigate the readiness of a sector and assess current policy.

4.1 How Use of the Metrics Suite Will Support the Creation of Business Value

We next offer three propositions on the creation of business value that reflect what we have learned so far from businesses and government agencies in Singapore. The propositions are not yet based on deep empirical analysis, which we plan to do later.

Cloud computing is more than just a new IT. It will lead to fundamental changes in how enterprises conduct their IT-related activities. Bringing cloud solutions into a firm makes it necessary to mitigate business risk, and understand the potential for strategic advantage [Iyer and Henderson 2012]. The purpose of our metrics suite is to facilitate

adoption and help organizations to gauge whether it will create business value. An organization may need to adjust its business model, strategic goals, risk management, and IT governance policy. This is hard: changes and adjustments may need to be made simultaneously. The metrics suite is helpful, since it offers a balanced view of adoption readiness across technology, economic, organizational, and external factors. We assert:

- **Proposition 1 (The Business Value Versus IT Risk Proposition).** *A metrics suite for adoption readiness will help a firm shift focus from the expected level of business value through adoption to balancing value versus risk to support appropriate adjustments in the adoption process.*

The value of cloud computing will be larger when firms are able to make appropriate adjustments. The metrics suite supports managers to identify where changes are needed so they can appropriate the maximum value from cloud computing.

Even as experienced users, some senior managers indicate that their organizations are still learning about the impacts and consequences of cloud computing adoption. Strategic planners want to identify the hidden costs, and then respond accordingly. This is a learning-by-doing process though. The hidden costs and frictions of externally-provided IT services will be revealed only when firms experience them first hand. In addition, role changes that affect IT staff and policy adjustments related to computing resource usage will not be fully understood before migration to the cloud starts.

Our metrics suite emphasizes the role of organizational absorptive capacity, which depicts the path dependence of organizational learning when organizations face new innovations [Cohen and Levinthal 1990]. The experience acquired through managing cloud adoption using metrics will help organizations build cumulative knowledge for handling disruptive innovations. Since not everything can be planned in advance, decision-makers need to be open-minded about cloud computing. We suggest:

- **Proposition 2 (The Organizational Learning Proposition).** *A metrics suite will aid decision-makers to view adoption as a learning process. Managers need to identify possible concerns, risks, and costs prior to adoption, apply ongoing adjustments to support value production, and transform the organization's operational and business models after adoption has occurred.*

The metrics suite that we have proposed can be used to evaluate an organization's adoption readiness, regardless of what stage it is in: before adoption has started, during the process, or after it finishes. We encourage decision-makers to plan to learn, to manage unanticipated roadblocks along the way and be effective.

The design of an organization's structure, process, governance and transaction contents create value through the exploitation of business opportunities [Amit and Zott 2001]. The paradigm shift resulted from cloud computing allows management decision-makers to redesign these business transaction-making processes to achieve business model innovation [Chesbrough 2010]. To make business model innovations, organizations need reliable and informative metrics for continuous monitoring and improvement of their performance. Our metrics suite encourages post-adoption performance measurement. Cloud adoption is not the final goal though: higher revenues and improved stakeholder satisfaction are. So we offer:

- **Proposition 3 (Business Model Innovation Proposition).** *A metrics suite for cloud computing adoption readiness will encourage an organization to implement continuous performance monitoring, which can support cloud-based business model innovation after the adoption process has finished.*

4.2 Discussion

To answer the research questions for this work, we developed an initial design of a firm-level cloud computing adoption readiness metrics suite. Enterprise users need reliable measurement tools to support their decision-making process for the costly move to cloud computing. Senior managers from industry, industry organizations, and government motivated us to conduct this research, and we subsequently interviewed them to support our effort to create the metrics suite. To address cloud computing adoption readiness more fully, we have sought to integrate knowledge from industry and university research to reflect the strengths of practice and theory. The initial design of cloud computing adoption readiness metrics suite is the result of this process that led to the definitions of the categories, sub-categories and measures presented in this article.

There are a couple of remaining concerns related to the development and application of our metrics suite. The industry CIOs and CEOs, government agency analysts and policy-makers offered us many useful ideas on how to improve the metrics suite. They also cautioned us about the how much effort will be required to instantiate the knowledge that our metrics suite requires. First, our metrics suite currently has 24 measures, which we expect to distill down to about 12 to 14, based on the input we obtained. We will only do that based on additional input, and the experience we gain from additional pilot testing. Most of our measures are grounded in theory, a good feature, but pilot testing we already have done led to adjustments to de-emphasize some aspects of our theory that were viewed as being unnecessary by practitioners. We will continue to fine-tune our measurement approach to best suit the intended beneficiaries of this research. We recognize that there is a trade-off between the extraction of appropriate knowledge from our respondents and the cost of its acquisition. They must buy into the results too.

Second, our metrics suite is comprehensive, but we still are seeking more thematic focus. Some respondents suggested that it would be useful to have a survey on the way that regulatory and external issues affect adoption readiness at the firm level. Others told us that economic and business value concerns are paramount. This suggests our research effort will have degrees of freedom for more in-depth exploration.

Finally, the reader should recognize that this is work-in-progress. As a result, we are still learning from the respondents who will make up our final sample. We are fortunate to have support from numerous business, government agency, vendor and consulting organizations, and look forward to reporting new results at GECON 2014.

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Appendix A. Cloud Readiness Metrics Suite: Categories, Sub-Categories, Measures, and Measurement-Related Comments

Categories, Sub-Categories	Sub-Categories, Measures and Proxies	Measurement Comments	Supportive Literature	Related Disciplines
Technology and performance. Assesses whether the characteristics of cloud computing solutions fit the firm's IT and systems. The measure sub-categories include: *self-assessments of compatibility, expected service quality*.	**Compatibility.** The degree to which cloud computing technology fits with the potential adopter's organizational values, practices and needs. Proxy measures are: *network access* and *virtualization preparedness.* **Cloud computing services quality.** Service quality that a client expects with cloud services. Proxy measures: *security, availability* and *scalability*. *Security risks* are contract loopholes, data privacy, information security, and service outages. *Availability* refers to the percentage of time a client can access the services. *Scalability* measures a client's desire to consume services that scale to demand.	**Measures.** Perceptual scales adapted from cloud computing. **Validation.** Efficacy and empirical validation are in process via pilot test interviews.	Armbrust et al. 2010 Grover et al. 1996 Pitt et al. 1995 Vouk 2008 Garg et al. 2013 Jamshidi et al. 2013	Software engineering Service science Cloud computing
Organization and strategy. Assesses to what extent cloud computing matches with firm's strategic orientation and organizational capacities. Sub-categories are *self-assessments of strategic orientation and firm capabilities*.	**Strategic orientation.** The degree to which senior managers support technology innovations in the firm. Proxy measures are: *executive support, organizational innovativeness, and perceived strategic value of the cloud*. **Organizational capabilities.** *Absorptive capacity* and *vendor management capacity*. Absorptive capacity: *external and internal knowledge acquisition and dissemination*. Vendor management capacity: *contractual and relational governance.*	**Measures.** Perceptual scales. **Validation.** Also in process.	Buyya et al. 2010 Aral and Weill 2007 Liao et al. 2003 Poppo and Zenger 2002 Messerschmidt, Hinz 2013 Low et al. 2011 Barczak et al. 2007	Cloud computing Strategic mgmt. Tech. adoption Outsourcing Grid computing
Economics and valuation. Assesses the economic suitability and business value of cloud computing in cost and benefit terms. The sub-categories include: *cloud services and market valuation*, and *vendor reputation.*	**Cloud service valuation.** Economic suitability assessment. Proxies include: *vendor pricing mechanism and contract flexibility, as well as the client's expected cost savings.* **Cloud market valuation.** Issues are *market maturity* and *available supply*. Proxies for market maturity measures are: *availability of performance standards, transparency of the cloud market*, and *perceived vendor reputation performance at market level*. Proxy measures for *available supply* are: *perceived abundance of supply*, and *availability of alternative services and vendors*. **Vendor's reputation.** Some key risks are the vendor's financial stability, scale economies, and cloud computing service delivery performance. Proxy measures include: *financial stability, and technical track records* pertaining to process maturity and published security breach and outages.	**Measures.** Perceptual, objective. Scales developed or adapted based on research, interviews. **Validation.** Pilot interviews only. Objective measures chosen for clarity and ease of application. Refinement and empirical validation are in process.	Truong and Dustdar 2010 Koehler et al. 2010; Li 2011 Hauff et al. 2014 ISACA 2012 Pauley 2010	Cloud computing IS economics Info security
Regulatory constraints and external environment. These shape an organization's strategic responses.	**Regulatory environment.** Many countries have laws for cloud vendors to keep customer data within national boundaries. The proxy is a scale for *perceived regulatory constraints*. **External business environment.** Three proxy measures are: *speed of technology change, mimetic pressure from competitors*, and *normative pressure from alliances*.	**Measures:** Perceptual scales adapted from the literature and self-developed. **Validation**: Refinement and empirical validation in process.	Miles and Snow 1978 DeSarbo et al. 2005 Walker et al. 2003 Messerschmidt, Hinz 2013	Strategic mgmt. Grid computing