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A Strategic Value Appropriation Path for Cloud Computing

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Abstract: Cloud-based information management is one of the leading competitive differentiation strategies for firms. With the increasing criticality of information management in value creation and process support, establishing an integrated capability with cloud computing is vital for organizational success in the changing landscape of business competition. These issues have received scant attention, however. We draw on the *resource-based view*, dynamic capability hierarchy concepts, and the perspective of *operand and operant resources* to suggest a cloud value appropriation model for firms. We argue that, to appropriate business value from cloud computing, the firm needs to effectively deploy cloud computing and leverage cloud operant resources as firm capabilities in a hierarchical fashion toward the development of cloud computing-based service models in order to reliably achieve the desired business outcomes. We propose a model encompassing the principles of infrastructure and cloud platform deployment, integration and service orientation, and alignment with business processes that explain the linkage from cloud computing to firm performance. We test this approach to value creation with a cloud computing implementation assessment model using a sample of 147 firms that have implemented cloud computing in India. Our analysis uncovers a *strategic value appropriation path* from cloud technological capability to firm performance via cloud integration capability, cloud service portfolio capability, and business flexibility. This research offers new insights regarding the underlying mechanisms for how cloud computing affects firm performance via cloud-enabled capabilities and the business functions that are supported by cloud capabilities.

Key words and phrases: Cloud computing, firm capabilities, IT services, IT strategy, organizational management, operand and operant resources, resource-based view, synchronization, technology implementation, strategic value appropriation path.

Introduction

Cloud computing represents a transformational shift in information technology (IT) that is changing how organizations utilize, manage, and deliver services over the Internet [18]. In the last decade, there has been tremendous growth in the provision of cloud-based technologies and services; as a result, it has increasingly become a mainstream and strategic choice for differentiation among firms. The cloud market is growing at a rate of 20 percent to 25 percent a year, and reached a size of US$127 billion in 2018, with approximately 30 percent of worldwide enterprise applications in the market offered via the cloud [30]. This fast-paced growth is attributable to the ease of acquisition and flexibility of cloud computing services.

The potential value of cloud computing has encouraged firms to deploy a variety of cloud-based service and business models [22]. Such models are not without risk though, and recent failures of cloud implementations have raised questions regarding their sustainability and feasibility (Appendix Table A1). Common reasons attributed to failures include lack of integration and poor service orientation. Although most implementations of cloud computing leverage data and information sharing in or across organizations, the extent to which data exchange meets business objectives often varies widely [50]. Anecdotes of failures suggest that effective utilization of the cloud to deliver value as services and usable data is a key factor to achieving success for a cloud business model. The data and information exchanged need to facilitate higher-level functions and operational processes that bring value to firms.

To shed light on how firms can leverage cloud resources to appropriate value, this study addresses three gaps in our scholarly and practical understanding. First, there is a need to assess the "interplay between the cloud's inherent capabilities and its transformative value" and how cloud computing affects the "capabilities of internal and external IT [and business] functions" [6, pp. 1–2]. The dearth of effort on related issues – especially the lack of guidance for overcoming design, delivery, operational, and integration issues – is among the reasons why cloud performance in organizations is still less than best. To date, cloud computing research has been dominated by studies that examine technological issues and has paid less attention to the business perspective [61]. Second, there is scant evidence or explanation of the paths from cloud computing to firm performance, resulting in a lack of practical guidance for firms. Little is known regarding how value appropriation from cloud computing is achieved through the orchestration of relevant resources and capabilities. Third, there is a need for research on the integration of cloud systems with existing legacy systems and its importance in firms' generation of business value from cloud computing. With the spread of cloud computing solutions implemented by firms alongside their legacy systems, this is an important gap, both from a research and a practical perspective.

We draw on the *dynamic capability hierarchy* concept [92] and *operand and operant resources perspective* [20, 53], and argue that, to appropriate value from cloud computing, the firm needs to effectively deploy and leverage different levels of resources for developing service models to reliably achieve desired outcomes.[1] A distinguishing characteristic of cloud computing is that it "is an [IT] service model where computing services (hardware and software) are delivered on-demand to customers over a network in a self-service fashion, independent of device and location" [56, p. 177]. Thus, cloud computing is an IT service, with the vendor providing and maintaining software and infrastructure, and the client integrating and utilizing services [27]. The rationale for a hierarchical approach is that different levels of cloud resources need to be developed, coordinated, and integrated such that they provide business-wide solutions and service offerings that generate value for stakeholders.

The operand-operant resources perspective [53] suggests that *operand resources* are typically physical resources upon which an operation is performed. In contrast, *operant resources*—the focal resource category in this study—are capabilities that leverage operand resources to create value. Operant resources are *hierarchical: basic operant resources* operate on operand resources, and *composite operant resources* are comprised of two or more basic operant resources. This aligns with early work on hierarchical capability in an organization. Winter [92] proposed that zero-level capabilities permit a firm to create value in its present operational state using stationary processes. However, for sustained performance, a firm needs higher-order capabilities that can create, extend, or modify its lower-order capabilities [19]. Such capabilities are dynamic; they "govern the rate of change of ordinary capabilities" [92, p. 992].

Based on the theoretical foundations for the *dynamic capability hierarchy* [92] and the *operand-operant resources* [53] perspective, we develop a model and hypotheses that connect cloud capabilities to firm performance. We test the hypotheses based on data collected from a sample of cloud user organizations in India. We find broad support for the model, discuss the results, and provide managerial implications and theoretical contributions. This study offers a new theoretical understanding of cloud computing as a service-oriented model built on a hierarchy of resources. We use the research model to offer a new *strategic value appropriation path* from cloud computing to value creation and appropriation.

The *strategic value appropriation path* that emerges from our analysis represents a more effective path for firms to follow in order to derive value from cloud computing. This value appropriation path is along the lines of the suggestion in prior research that information and IT capabilities can pave specific paths to economic value [43]. The value appropriation path is not a temporal path, but a logical sequence of activities that draws from the capabilities of an organization to orchestrate cloud resources in a synchronized manner to create business value. It creates a new basis for managers to consider how to assess internal capabilities and to assess why cloud computing has not paid off to the expected extent. The strategic value appropriation path deepens managerial understanding of cloud implementation corrections.

Prior Literature

This section covers three aspects of the literature for the cloud computing operant resources-based view of capabilities. The hypotheses we will present later draw on literature related to cloud computing, resource-based theory and its relationship to IT capabilities, and the formulation of the firm's capability hierarchy based on the operand-operant resources perspective.

Cloud Computing

Related research can be found in Information Systems (IS), Computer Science, and Strategic Management. We reviewed numerous articles on cloud computing in the AIS Senior Scholar's Basket of eight journals, and *MISQ Executive*, with a few articles from other outlets. Most studies were exploratory, descriptive, or based on cases, and not quantitative. We focus on studies of four cloud computing aspects: (1) technology; (2) services provisioning; (3) integration with other systems; and (4) cloud value in the firm.

Based on the technology and service provisioning aspects, cloud characteristics that help increase business value are scalability, location independence, sourcing independence, ubiquitous access, and rapid elasticity [35, 36]. In some cases, the value proposition for cloud adoption is to mitigate management failures for on-premise applications [86]. Institutional influences, firm size, perceived benefits, business concerns, and IT capabilities are other determinants of cloud adoption [72]. Still others are data security, technical competence, cost, and management support.

From a value perspective, cloud computing enables sense-and-respond strategies, such as dynamic resource commitment, modular process design, and operational learning. These strategies facilitate organizational transformation through business process and network redesign, and scope redefinition [5]. These higher-level changes positively influence firm performance through better quality and innovativeness, as well as cost and time savings. Firms also derive value through interactions between their cloud delivery models and IT capabilities, such as relational and technical IT capabilities [27]. Customizability, interconnectivity, and alignment also facilitate competitive advantage by enhancing innovation and collaboration with partners. Prior theory suggests cloud computing can influence the structure of the firm's IT as a profit or cost center [17], as well as influence market structure, firm profitability, and consumer welfare [14].

Our review of the four substreams of literature suggests that the integration and information management challenges of cloud adoption in firms deserve more attention. This is important because of the complexities of cloud delivery, and the options that businesses have in its adoption. In contrast, the practitioner press recognizes the lack of infrastructure integration with other systems in the organization—leading to data silos—as a challenge [50]. Thus, it is critical to understand the impact of cloud functionality and services utilization on firm performance. This encourages researchers to create new theory and test mechanisms underlying how cloud computing leads to performance. To understand how integrated cloud capabilities influence firm performance, we draw on the IT capabilities perspective.

Resource-Based Theory and IT Capabilities

Prior studies indicate that firms leverage two strategic mechanisms: capability building and resource selection for creating economic rent [54]. *Capability-building* refers to the ability to integrate, build, and reconfigure internal and external resources to create unique competencies. These capabilities are embedded, making them valuable and inimitable, and superior to resources alone as drivers of long-term performance [8]. *Resource selection mechanisms* can create competitive advantage when firms apply superior information and knowledge with their resources and build capabilities [54].

Firms are diverse and differ widely in developing unique resources involving IT-based assets and capabilities [89, 90]. Prior studies have indicated that the impact of IT capabilities occurs at the level of organizational processes that use IT resources, data assets, and portfolios [13, 38], and yet IT infrastructure is not sufficient to explain firm success. Firm success depends on abilities to: (1) effectively manage IT infrastructure to support operations, processes, innovation and decision-making; (2) develop information management processes to gather, organize, and disseminate information; and (3) instill values for effective use of information [55]. Although IT infrastructure provides a foundation and acts as a precursor for value creation, the firm's *information management capability*, the "ability of firms to leverage their IT infrastructure to provide accurate, timely and reliable data and information to users" [59, p. 238] is a key factor.

We use the *resource-based view* (RBV) and IT capabilities literature, which we describe next, to support our model. We propose that the firm needs to effectively deploy cloud computing and develop different cloud-enabled capabilities to achieve desired outcomes and appropriate value. By applying the concepts of operand and operant resources [20, 53] to the cloud context, we offer a new foundation.

Capability Hierarchy Based on Operand–Operant Resources

Two aspects of the cloud business model motivated our theory work. First, for resource deployment and value creation, a challenge is that the firm which deploys and manages resources is different from the firm that leverages them. While the client as a consumer leverages resources to consume services, the provider deploys resources and builds its business around them to create value [23]. The cloud services provider is responsible for various IT activities, such as hardware and software installation, upgrades, and data storage [27]. Second, cloud resources deployed by the provider need to synchronize and integrate with the client's technology resources to enable business capabilities and generate value through the service-business delivery model. Thus, resource deployment, synchronization, integration, and service orientation are essential. Cloud technology resources cannot create value by themselves for the client; they require that the integrated cloud model and service orientation of the cloud architecture are effective.

We develop our research model by drawing on two theoretical concepts that are related and conceptually build on each other. First, we utilize the *dynamic capability hierarchy* concept [19, 92] and apply it to the context of cloud computing based on the premise that cloud implementations must dynamically engage firm resources to create value [29]. Winter [92] conceptualized a hierarchy of capabilities that firms possess. The lower-order capabilities are firm competencies that provide firms with basic capabilities. Lower-order capabilities only “perform basic functional activities” [19, p. 145]. What firms need to develop are higher-order capabilities that operate to extend ordinary capabilities and “govern the rate of change of ordinary capabilities” [92, p. 992]. Dynamic capabilities thus reflect the firm’s ability to integrate, build, and reconfigure tangible and intangible assets [82]. The *capability hierarchy perspective* suggests that development of hierarchical capabilities enables firms to achieve high performance outcomes.

Second, we apply the concept of *operand and operant resources* [53]. Such resources are hierarchical: they leverage one another to create value. *Operand resources* are physical resources upon which an act or operation is performed; whereas, *operant resources* leverage operand resources to create value. Madhavaram and Hunt [53] discuss a *hierarchy of operant resources* (basic, composite, and interconnected operant resources) that act on operand resources or other operant resources to create value. According to Madhavaram and Hunt [53, p. 67], “competences, capabilities, and dynamic capabilities can be viewed as operant resources.” Thus, this is consistent with the capability hierarchy perspective [92], and together they serve as a useful theoretical grounding to build our research model. In line with this view of the hierarchy of capabilities and the conceptualization of operand-operant resources, cloud-related capabilities are operant resources, an extended representation of hierarchical dynamic capabilities [33].

Theoretical Conceptualization, Research Model, and Hypotheses

We next discuss our theoretical basis for the cloud operant resources view that we offer to create the basis for our cloud computing value appropriation path model, and the underlying hypotheses.

Conceptualizing the Theoretical Argument Involving Cloud Operant Resources

To conceptualize cloud operant resources, we draw upon the cloud computing and practitioner literature. For the technological aspect of cloud computing, we contend that it is not simply deployment that matters, but rather the extent to which the cloud is effectively deployed such that firms are able to leverage its defining characteristics. This enables architectural modularity and infrastructure flexibility [57], represented by distinctive cloud characteristics. They include resource pooling, interoperability, and provisioning [58]. However, although many firms may deploy cloud computing technology, firms differ in the extent to which they lever the defining characteristics of cloud from its underlying technology. For instance, each cloud offering has its own set of rules regarding how clients’ applications and users interact with the cloud implementation [63]. Lacking process standardization hinders cloud ecosystem development and impacts the optimization of resources within an organization. Thus, firms may experience varying levels of interoperability, depending on the skills with which the cloud was deployed [7, 57].

We conceptualize the first level of cloud resources as a *basic operant resource*. "[A]n entity is a resource to the firm if, and only if, it contributes to enabling the firm to produce efficiently and/or effectively a market offering that has value for some market segment(s). [So] basic operant resources may be viewed as the underlying, lower-level, resources that form building blocks of higher-order, operant resources" [53, p. 70]. Such resources may be skills and knowledge of individual employees, or their application in a business context. The capabilities of cloud architecture (e.g., resource pooling, elasticity, provisioning) result from such skills and knowledge applied to the operand resource of cloud technology.

This resource is *Cloud Technological Capability* (*CTC*). It is a basic operant resource because it acts on the operand resource of cloud technology, and it is not comprised of other operant resources. We define it as the capacity of a firm to deploy cloud-based platforms that are available on-demand via the Internet to serve consumers via pooling of resources in a manner that is scalable and measurable. This capability is formative and encapsulates essential characteristics of cloud computing: on-demand, broad network access, resource pooling, rapid elasticity, and measured service [58]. This capability reflects the quality of the cloud infrastructure for how stable, scalable, and extensible it is.

The second level of cloud resources is the *composite operant resource*, "a combination of two or more distinct, basic resources, with low levels of interactivity, that . . . enable the firm to produce . . . valued market offerings. The lower-order resources (basic operant resources) collectively comprise the (composite) operant resources. [M]ore of each of the lower-order resources . . . will contribute to increasing a firm's composite, operant resource" [53, p. 70].[2]

Consistent with composite operant capabilities, we define *Cloud Integration Capability* (*CIC*) as the ability of a firm to maintain consistency between its cloud-enabled functionality and data, and legacy system functionality and data. It represents the degree to which a firm's cloud-based functionality and data are synchronized and integrated consistent with its legacy IT systems. This definition uses data consistency and cross-functional application systems integration concepts [67] but is adapted for our context. Composite operant resources can be formatively specified as a combination of basic operant resources [53].

We offer two related basic operant resources based on the salient characteristics of cloud business models [5, 58]. First, cloud solutions are implemented by vendors and accessed at client sites, so an important consideration is how the cloud is synchronized and made consistent with legacy applications for the client. It needs to retain its in-house IT assets associated with its core competencies (e.g., an ERP system) while utilizing cloud options for other functions. Frequent communications between cloud-based applications and on-premise systems are required to run the business effectively. However, if the cloud service provider uses proprietary interfaces and has complex data structures that do not align well with in-house IT systems, it will lead to difficulties impacting data integration and functionality.

A basic operant resource is the *Cloud Legacy Consistency Capability* (*CLCC*) of the firm. It is defined as the degree to which application functionality and application data elements are common across the cloud and legacy applications in the firm. We refer to the second of these as the *Cloud Legacy Synchronization Capability* (*CLSC*) of the firm and define it as the degree to which cloud and legacy functionality and application data are updated and synchronized with each other in real time. Thus, *CLCC* is distinct from *CLSC* in that *CLCC* pertains to definitions of functional and data elements; whereas, *CLSC* pertains to real-time updates and synchronization between cloud and legacy systems. The *CLCC* and *CLSC* basic operant resources together equip the firm with *CIC*, a composite operant resource which creates the capacity to make cloud computing work well with legacy applications.

We note another basic operant resource: the *Cloud Service Offerings Capability* (*CSOC*) of the firm. Cloud computing has the capacity to enable services [76] by committing resources dynamically according to business needs and providing on-demand access to configurable IT resources. This is achievable because of cloud computing's dynamic discovery, resource pooling, and ability to bring together IT resources. It also enables firms to manage information by collecting, analyzing, and generating ideas and recommendations from a variety of data sources in their business networks. The ability of the cloud to support dynamic discovery and information management implies that its services may help organizations identify and compose relevant services to create customized solutions [10].[3]

Next, consider *Cloud Market Offerings Capability* (*CMOC*), a basic operant resource: the firm's capability to align its cloud services with its providers' external offerings. This facilitates a firm's ability to connect, interoperate, collaborate, and complement cloud offerings, such as the payment gateways of other firms. Cloud services may not be enough to support all of the firm's needs: the market offerings of a cloud service provider are highly relevant too.[4] A firm's interconnections with external market participants' cloud services determine its cloud market offering readiness. *CSOC* and *CMOC* give firms superior capability for services and market portfolio offerings, forming a composite operant resource, *Cloud Service Portfolio Capability* (*CSPC*). Appendix Table A2 summarizes how we derived the operant resources.[5]

For value creation from cloud computing, simply having cloud hardware and software resources is not sufficient [27]. Composite cloud operant resources need to be developed to support effective service value creation. A key contribution of our research inquiry is that defining a *strategic value appropriation path* can offer useful guidance for organizations to develop such composite resources to create business value by leveraging the cloud's service orientation.

Our overall theoretical argument follows. (1) Cloud computing is service-oriented and supports dynamic engagement of resources to produce value. (2) Resource-based value is relevant in leveraging cloud computing for business value creation. Resources alone do not create value though; they are only enablers for services, while agile technical infrastructure permits the creation of other new cost-reducing and revenue-producing technology solutions. (3) Cloud hardware, software, and applications are operand resources, and unless they are operational and used, they will not create value by themselves. (4) Value can be appropriated via development of a hierarchy of basic and composite operant resources that act as value-creating levers for technical cloud resources—the operand resources. We will show how the related constructs and survey items can measure these resources to assess this new theory.

New Theory: A Strategic Value Appropriation Path Model for Cloud Computing

We offer a theoretical model to explain how cloud capabilities deliver value to firms through the enablement of cloud service capabilities via the development of cloud operant resources (Figure 1).

To effectively share the essence of the ideas and theoretical basis for our research model, we next present how the model's constructs relate to one another, and eight hypotheses that are implied therein. We offer an overview of the theory and literature that support our specification of the capability, flexibility, and performance constructs (Appendix Table A2). We remind the reader that "all competencies/capabilities can be viewed as operant resources," and also that "composite operant resources can be either tangible or intangible" [53, pp. 69–70]. These observations support our theory.

Hypotheses

Development of Cloud Operant Resources

Our first hypothesis covers how *Cloud Technological Capability* (*CTC*, a basic operant resource) helps a firm develop *Cloud Integration Capability* (*CIC*, a

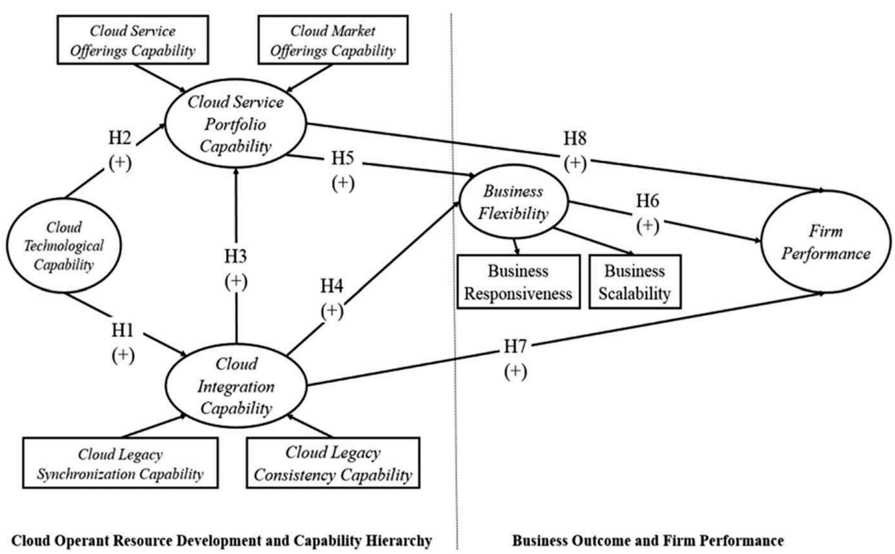

Figure 1. The Cloud Value Appropriation Path Model.

composite operant resource). *CTC* helps to develop capabilities for *CIC* with basic operant resources, *Cloud Legacy Consistency Capability* (*CLCC*), and *Cloud Legacy Synchronization Capability* (*CLSC*). These two are formative first-order constructs. Consistency and synchronization capabilities make contributions to the second-order construct *CIC* and can be viewed as forming it [15]. In addition, development of a capability to integrate cloud computing with existing legacy systems (e.g., CRM, ERP) facilitates information exchange across stakeholders. Here, though, cloud systems must be integrated across supply chain partners with differing needs and technical environments to successfully deliver outcomes.[6]

First, *CTC*'s technology thrust is to dynamically provision the cloud, mobilizing resources, and monitoring infrastructure use to enable cloud technology and functionality to work in tandem with existing IT infrastructure. Built-in support allows legacy systems to connect with cloud systems, ensuring the data and functionality are consistent with legacy systems in a scalable manner. Second, effective cloud technological capability enables the cloud platform to be synchronized in real time with legacy systems via standard interfaces that enable interconnectivity, reflecting platform synchronization. This enables data from legacy systems to be utilized by cloud applications in real time [5]. In sum, a well-developed *CTC* basic operant resource enhances the firm's ability to develop *CIC* (a composite operant resource) via platform synchronization and technology-based consistency. As a result, we offer the following hypothesis:

> *Hypothesis 1 (Technology and Integration): The higher is CTC, then the higher is CIC.*

We next consider how *CTC* enables the firm's development of *Cloud Service Portfolio Capability* (*CSPC*, a composite operant resource). *CTC* facilitates the creation of capabilities that form *CSPC*, including *Cloud Service Offerings Capability* (*CSOC*) and *Cloud Market Offerings Capability* (*CMOC*). These two basic operant resources are also first-order formative constructs for *CSPC*. Superior *CTC* enables the firm to enhance its *CSOC*, which, in turn, supports the firm's *CSPC* via on-demand dynamic provisioning and resource allocation [35]. Dynamic provisioning and resource allocation ensure that varying customer needs can be met and services be made available [86]. They also enable firms to elastically utilize resources on-demand, which is a flexible way to run service apps without advanced reservation of resources and with minimal effort or provider interaction.[7]

CTC helps align a firm's cloud-based services with cloud market services. For example, effective provisioning of cloud-enabled accounting systems ensures seamless connectivity with the variety of billing and accounts receivable systems of its market participants. Superior *CTC* via dynamic provisioning and standard interfaces helps a firm to develop cloud applications that are well aligned, interoperable, and compatible with systems of other market participants [5]. This is achieved via standard interfaces with the applications and service offerings of other market participants [78]. In sum, a well-developed *CTC*, a basic cloud operant resource, enhances a firm's ability to develop *CSPC*, a composite operant resource, via the cloud's ability to support its service offerings and external compatibility. Therefore, we propose:

> *Hypothesis 2 (Technology and Service Portfolio): The higher is CTC, then the higher is CSPC.*

We next consider how the composite operant resource, *CIC*, helps a firm develop *CSPC*, also a composite operant resource. Firms use various deployment models and source cloud services from different vendors. Variations in utilization and data synchronization result in cloud silos, which lead to inefficiencies and redundant, inconsistent data, with no "true" single version for assessing real-time firm performance.[8] Similarly, the variety of vendor proprietary platforms, languages, and technologies results in the *vendor lock-in problem*, increases switching costs for subscribers, and may lead to incompatibility with the services of other vendors.[9] An integrated cloud-legacy environment provides accurate and reliable information, delivering usable data and services to stakeholders. As a result, the more capable the firm is with integration in its existing infrastructure, the more effective it will be in information management.

IT-enabled information management capabilities enable business capabilities [59] and support effective integration with legacy systems, resulting in a well-performing, integrated portfolio of services for multiple environments with data sharing. When cloud systems and legacy systems are well-integrated, this helps the firm to achieve an aligned enterprise architecture, data and process integration, and a consistent discipline for problem and change management. These outcomes aid in deploying and managing services.

Furthermore, integration of cloud technologies with existing IT infrastructure enables an effective service portfolio. A firm's synchronization of data across its cloud and legacy systems ensures its cloud-based functionality seamlessly connects with existing services and processes.[10] Finally, because *CIC* enhances such data synchronization, it can facilitate streamlined data sharing for the cloud offerings of other firms.[11] As a result, superior *CIC* helps a firm to enhance its *CMOC* through interoperability. Thus, we posit:

> *Hypothesis 3 (Integration and Service Portfolio): The higher is CIC, then the higher is CSPC.*

Mediating Role of Business Flexibility

Business Flexibility (*BusFlex*) is the ability of a firm to quickly deal with business environment changes. By enabling alignment with processes, *BusFlex* acts as a mediator that funnels the effects of *CIC* and *CSPC* to *Firm Performanc*e (*FirmPerf*). This ability is manifest in two ways. *Business Responsiveness* (*BusResp*) allows a firm to respond to business environment changes by quickly reallocating and reconfiguring organizational resources, processes, and strategies [83]. It is implemented through analysis of performance-relevant metrics. *Business*

Scalability (*BusScal*) is the firm's ability to quickly manage its resources to cope with expanding or diminishing business needs. It is implemented through predictive change management processes [83]. In other words, *BusFlex* is formed from a firm's ability to sense, respond, and synchronize strategic and tactical decisions [52].

CIC leads to *BusFlex*. First, synchronization and consistency between cloud and legacy applications data facilitate alignment and adaptability of business processes and systems, enhancing the ability to sense the business environment [5]. They facilitate organizing, linking, analyzing, and sharing information gathered about markets, competitors, and stakeholders across relevant business units [41]. This ensures the right information is available on time for effective decision-making.[12] With greater *CIC*, a firm can reallocate its organizational resources, processes, and strategies for responsiveness [5]. Second, with synchronization and consistency between cloud and legacy systems, a firm will be able to better monitor resource use. This supports real-time predictive change management, which increases *BusScal*. Therefore, to be flexible for business changes and scalable in operational size, firms need to ensure that the data in all their cloud-based and legacy systems and apps are well-integrated, synchronized, and consistent. Such integration supports exceptional information management to develop and enhance internal organizational and business processes that can meet changing business needs [59]. Thus, we assert:

> *Hypothesis 4 (Integration and Flexibility): The higher is CIC, then the higher is BusFlex.*

Next, we argue that *CSPC* enhances *BusFlex*. First, a flexible firm-level portfolio of cloud services enables it to adapt its services to meet change. Firms that use the cloud to design and deploy service offerings will be able to identify changes in demand and the environment. As a result, their ability to sense and respond to environmental changes will be enhanced. Likewise, the compatibility of its cloud services with those of its partners allows the firm to synchronize its offerings with the market's needs.

Second, a firm's business scalability will be enhanced by the interoperability and alignment of its cloud systems with the offerings of market participants. By using the cloud to develop and maintain services with market participants, it can quickly adapt or switch business partnerships, ensuring flexibility [58]. Similarly, the interoperability and alignment of its cloud systems with market participants enhance the firm's capacity to scale up or down quickly. Thus, we now offer:

> *Hypothesis 5 (Service Portfolio and Flexibility): The higher is CSPC, then the higher is BusFlex.*

Next, we suggest that *BusFlex* mediates the link between *CIC* and *FirmPerf*, as well as the link between *CSPC* and *FirmPerf*. *BusFlex* enables the firm to be agile and responsive to changing business environments, supporting real-time synchronization of key decisions. Consistent with these capabilities, we expect that business flexibility should enhance firm performance; therefore, we hypothesize:

Hypothesis 6 (Flexibility and Performance): The higher is BusFlex, then the higher is FirmPerf.

Our final hypotheses link *CIC* and *CSPC* to *FirmPerf*. Superior *CIC* enables data from legacy systems to be available to cloud applications, resulting in effective operations for the firm and its business processes [28]. Improvements supported by cloud computing enable it to enhance productivity and financial performance [68]. *CIC* also enhances the firm's information management processes to gather, organize, and disseminate information and data to stakeholders in a distributed and pervasive way. Overall, effective integration increases the access of key ITs and scale economies for technical resources too.[13] As a result, these capabilities help resource use and manage internal and external business processes effectively [59].

Likewise, *CSPC* enhances firm performance two ways. First, by helping in the design, development, and management of services, it enhances service quality, and the breadth of services it offers to customers. This is because cloud-enabled services provide improved mobility and accessibility of firm services [5]. The improved service experience benefits customer satisfaction, reducing churn and growing revenue. Second, better *CSPC* helps to develop and maintain services at lower cost because the firm controls its hardware, facilities, and other operations costs. Finally, *CSPC* helps firms lever capabilities offered by market participants in a more seamless and cost-effective way, potentially opening up opportunities for partnering more effectively and efficiently with other market participants. Additionally, superior *CSPC* allows the firm to focus more on its core business [28]. Therefore, we state:

Hypothesis 7 (Integration and Performance): The higher is CIC, then the higher is FirmPerf.

Hypothesis 8 (Service Portfolio and Performance): The higher is CSPC, then the higher is FirmPerf.

Data, Methods, and Analysis

We next provide an overview of our dataset and variables, a roadmap for our methods, the rationale for using *partial least squares* (PLS), and other techniques to support our ability to make inferences, as well as the benefits they offer for learning about the firm's implementation paths for high value appropriation.

Data Collection and Variables

To test our hypotheses, we conducted a cross-sectional matched-pair field survey of organizations in India, an emerging economy with large number of users of cloud computing services. The Indian cloud services market is growing rapidly and likely to become the third largest cloud service technology ecosystem globally, behind China and Indonesia.[14] Thus, India is an appropriate context for our study.

Our constructs were operationalized by utilizing existing scales where available, or developing new scales through adapting prior measures.[15] For example, we used the five characteristics of cloud computing: on-demand, broad network access, resource pooling, rapid elasticity, and measured service [5]. We also used the National Institute of Standards and Technology's definition as a basis for the *CTC* scale [58].[16] *FirmPerf* is multidimensional, comprising financial and market performance, and organizational effectiveness [59]. Scale items and sources from which they were adapted are shown in Appendix Table A3.

To minimize confounding factors due to uneven economic development in India, we developed a sample with data for firms that were located near two emerging commercial hubs in western and southern India (Mumbai and Bengaluru). We collated industry and city directories of two commerce hubs, with organizations that participated in a major business conference there. This resulted in 1,000+ firms. We then removed inactive organizations with no filings with India's Ministry of Corporate Affairs in the prior two years.

After cross-validating the initial instrument items with researchers and industry respondents, we localized the questionnaires by employing the *back-translation method* (e.g., [48]). A bilingual research assistant (RA) translated the questionnaire into the local language, and then a second RA translated it back to English. The two versions were compared, discussed, and refined. The items on our instrument were pretested with two academic IS and survey research experts, in addition to four senior IT managers as respondents.[17]

Matched-pair data were collected from February to September 2016 through anonymous surveys of volunteering organizations administered using an online and in-person methodology. We chose a *dual online-offline mode* to administer the survey for two reasons. First, the *online mode* ensured that respondent firms had Internet access, a prerequisite to using cloud computing services. Since Internet penetration in India is low, we targeted only the relevant subsample of firms. Second, the *offline mode* provided a check if the firm met eligibility criteria and respondents were authentic. Third, participation in online surveys also is low in India due to confidentiality concerns; in-person survey administration addresses this issue. Finally, to increase response rates and data reliability, we conducted follow-up calls and in-person meetings. Therefore, we hired and trained local RAs in India for gathering data. They sent emails to firms soliciting participation. The invitations explained the study's purpose and benefits. Two follow-up calls were made, in which the contact details of the two potential respondents were collected and participation confirmed. Last, surveys were administered via onsite visits and meetings arranged during and after local business conferences. A summary of our findings and a small souvenir incentivized participation.

Two senior managers at each organization were administered separate questionnaires, to collect the independent and dependent variables. The first collected dependent variables concerning business flexibility and firm performance from the top-ranking executive responsible (CEO or equivalent); they are likely to be most knowledgeable of a firm's strategy and performance. The second contained questions pertaining to the independent variables for cloud capabilities and was administered to the top-ranking IT executive (CIO or equivalent). We obtained data for control variables from both kinds of respondents. We separated our sources of information, reducing concerns about bias, and this design also allowed us to use items that were suitable to each respondent's domain knowledge.[18]

Descriptive Statistics

The final sample has 147 firms, after we dropped incomplete responses from 18 firms, and others from which we did not receive responses to both questionnaires. The firms hail from manufacturing, IT and services, food and healthcare, and other industries. The average *FirmAge* is 4.5 years and *FirmSize* is 1,554 employees. Tables 1 and 2 present the firm characteristics and descriptive statistics.[19]

Comparisons of the means of the key variables between early and late responders, online and in-person respondents, and responders and nonresponders did not reveal any statistical differences; therefore, bias was absent in our data collection. CEOs and CIOs that did not respond to our request for participation indicated a lack of time or adverse company policy regarding surveys.

Partial Least Squares Analysis

We used *partial least squares* (PLS), a *structural equation modeling* (SEM) technique, to validate our model. It estimates interrelated dependence relationships and

Table 1. Respondent Firm Characteristics

Characteristic	Category	%	Characteristic	Category	%
Industry	Manufacturing	20	*FirmSize*	< 100	53
	Services	24	(# Employees)	100–499	13
	New Econ. Firm	28		500–999	15
	Trading and Retail	21		1,000–4,999	8
	Food and Healthcare	7		5,000–9,999	5
				> 10,000	5
Ownership Structure	Foreign Subsidiary	12	*FirmAge*	1–5	55
	Joint Venture	17	(years)	6–10	20
	Indian Public	8		11–20	13
	Indian Private	63		21–30	7
				31–40	3
				> 41	2

Table 2. Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
BusFlex	5.73	2.09	1.93	9.08
BusResp	5.25	2.06	1.41	8.23
BusScal	5.43	2.12	1.70	8.69
FirmPerf	5.12	1.87	1.18	8.23
CSPC	4.49	1.44	1.61	6.68
CIC	4.30	1.64	1.26	6.93
CLCC	3.86	1.50	1.21	6.06
CMOC	4.10	1.41	1.37	6.18
CLSC	4.65	2.10	1.13	6.06
CSOC	4.00	1.48	1.21	6.07
CTC	5.05	2.14	1.19	8.34

Notes: Obs.: 147 firms, with full responses.

handles second-order formative constructs better than covariance-based SEM. It assesses a measurement model for the theoretical model and makes no assumptions regarding data normality. Although PLS is recognized for handling small samples, recent research asserts requirements for an adequate sample size. We must "multiply 10 times the scale with the largest number of formative (e.g., causal) indicators, or multiply 10 times the largest number of structural paths directed at a particular construct in the structural model" [51, p. 132]. Our model has 11 constructs and at most 4 structural paths directed at any construct; therefore, a sample size of 110 is sufficient. Also, the *power analysis rule* suggests that, for a model with 5 independent variables, a sample size of 122 is needed to achieve statistical power of 80 percent for detecting a R^2 value of 10 percent with a 5 percent probability of error.

Empirical Analysis and Results

Our methods roadmap is in Appendix Figure A1. We begin with an assessment of the measurement model and its factors, followed by a structural model assessment. Our path analysis and mediation results offer evidence for a path for firms to follow for extracting strategic value from cloud computing.

Measurement Model Assessment

Since our model consists of a mix of formative and reflective constructs, as shown in our methods roadmap, we adopted a three-step approach to determine measure adequacy. We conducted a principal components analysis with Varimax rotation, which generated the expected number of factors, with high loadings (above 0.70) and low cross-loadings (below 0.30). Six items with low loadings were dropped.

Table 3. Measurement Model Assessment for Reflective Constructs

Constructs	Cronbach's Alpha	AVE	Composite Reliability
FirmPerf	0.92	0.72	0.92
BusFlex	0.92	0.78	0.93
BusResp	0.90	0.72	0.93
BusScal	0.86	0.65	0.90

We assessed the reflective constructs *FirmPerf, BusFlex, BusResp*, and *BusScal* next. Internal consistency reliability is evaluated via the composite reliability scores, which were satisfactory at 0.92, 0.90, 0.93, and 0.93 (Table 3). We ran confirmatory factor analysis too: all variables exhibited sufficiently high reliability, with Cronbach's α always above the minimum recommended. We then assessed convergent validity based on outer loadings and *average variances extracted* (AVEs). Loadings of all retained indicators on their related theoretical constructs were significant ($p < 0.01$) and exceeded the recommended 0.70 threshold in the measurement model (Appendix Table A3). All AVEs were greater than 0.50 and higher than the highest shared variance between all possible pairs of constructs for each construct.

Finally, we assessed discriminant validity via cross-loading analysis and the *heterotrait-monotrait ratio*. Outer loadings of the indicators on the associated construct always exceeded the cross-loadings on other constructs. Furthermore, since the path model constructs are conceptually similar, the *heterotrait-monotrait ratio's* value should be below 0.90 for inferring discriminant validity. The ratios for all constructs are below the conservative threshold of 0.85 for conceptually distinct constructs [32].

Third, we assessed the formative constructs using different criteria; evaluations of reflective constructs do not apply to formative constructs [64]. We assessed convergent and discriminant validity by evaluating the weight, sign, and magnitude of items for the formative constructs rather than item loadings [15, 42]. The weightings of retained indicators on their related theoretical constructs were significant at $p < 0.01$, the signs of the item weight were consistent with the underlying theory, and magnitude of the item weights were greater than 0.10. Also, for each formative construct, the average weight for the formative items was less than the ceiling of $\sqrt{1/N}$, with N as the number of orthogonal formative items specified. One indicator was not significant and another had a high weight; however, in line with the guidelines, they were retained to preserve content validity and ensure that the constructs measured the entire domain (details in online supplement) [64]. We also performed redundancy analysis by comparing the correlations of formative constructs with global items that summarize the constructs [31]. The path coefficients all were above the suggested value of 0.70. And the *variance inflation factors* were less than the 3.3 threshold; therefore, multicollinearity is not a concern at the item level [64]. The model provided satisfactory fit across all indices, and the measures had adequate validity, reliability, and discriminant validity.

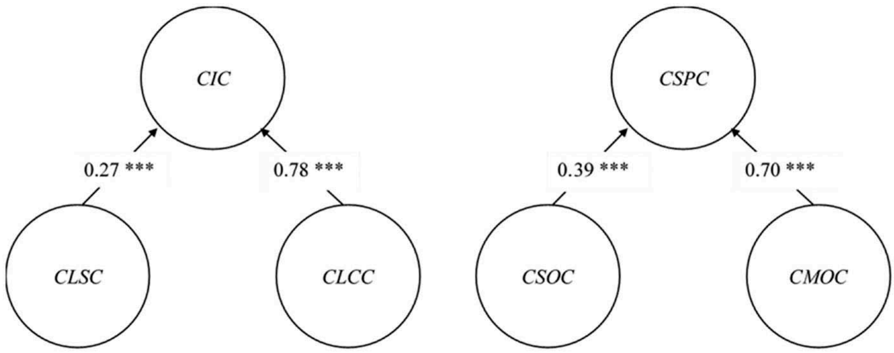

Figure 2. Second-Order Formative Construct Loadings.

We assessed the construct validity of the second-order formative constructs, and the reliabilities of both constructs were adequate. We also found that the first-order indicators reliably measured the second-order constructs. For this, we tested for a statistically-significant path coefficient between the first-order dimensions of each second-order construct, which represent the weights of the formative constructs.

Figure 2 shows that there are significant path coefficients between the first-order constructs [24]. They include: between *CSOC* ($\beta = 0.39$, $t = 5.78$, $p < 0.01$), *CMOC* ($\beta = 0.70$, $t = 11.76$, $p < 0.01$), and *CSPC*; and between *CLSC* ($\beta = 0.27$, $t = 3.13$, $p < 0.01$), *CLCC* ($\beta = 0.78$, $t = 10.00$, $p < 0.01$) and *CIC*. Further appropriateness of a formative model is shown by the significant, but not high correlations among first-order constructs. An alteration in any first-order dimension does not cause a change in the other dimensions; so a reflective model seems unlikely. Thus, we conclude that the proposed second-order formative constructs were supported. Altogether, these validate the measurement model's psychometric adequacy.

Structural Model Assessment

Moving on in the methods roadmap (Appendix Figure A1), we assessed the hypothesized PLS structural model and applied a *bias-corrected and accelerated bootstrapping* procedure with replacement using 5,000 subsamples. This enabled us to calculate the statistical significance of the parameter estimates. It relaxes the normality assumption for the individual variables' data distributions and is used for models that include mediation [25]. In PLS, the structural model specifies the relationship between the theoretical constructs. Our hypotheses were tested using a one-tailed *t*-test for *unidirectional hypotheses*. The analysis was performed with SmartPLS 3.0 (Figure 3).

Although our matched-pair data collection process and use of 5- and 7-point scale anchors reduced the common method bias threat, we performed three analyses to assess it. First, we conducted *Harman's one-factor test* [65, 66]. We entered all the variables for exploratory factor analysis; no single major factor emerged, with only 39.3 percent of

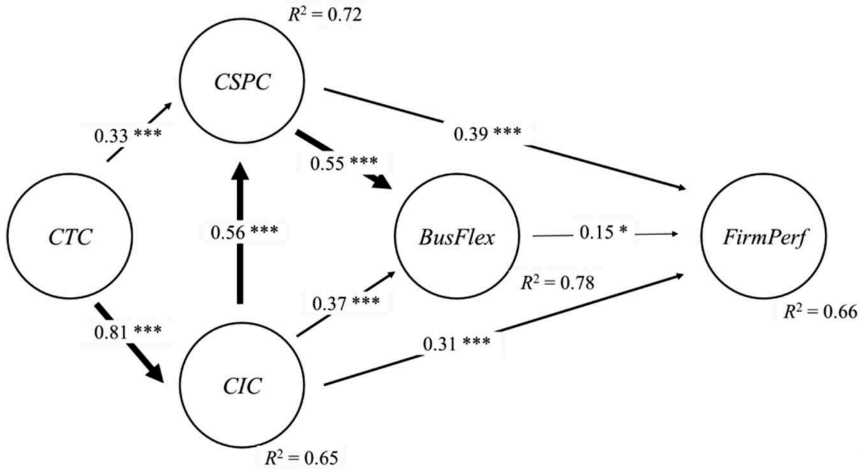

Figure 3. PLS Structural Model Estimation Results.
Note: Significance: *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. Line thickness signifies effect size. small, medium, large.

variance accounted for by the first factor. Second, we used the *partial correlation method* [66] and added the highest factor from the factor analysis to the PLS model as a control variable. It did not produce a significant change in variance explained. Finally, we added a construct to the model not related to our theory to perform the *marker variable test* [49]. The results suggest that common method bias is not a concern.

Our results indicate *CTC* had a positive relationship with *CIC* ($\beta = 0.81$, $t = 21.92$, $p < 0.01$), supporting the Technology and Integration Hypothesis (H1). It also was positive for *CSPC* ($\beta = 0.33$, $t = 2.90$, $p < 0.01$), supporting the Technology and Service Portfolio Hypothesis (H2). Furthermore, *CIC* had positive effects on *CSPC* ($\beta = 0.56$, $t = 5.43$, $p < 0.01$), *BusFlex* ($\beta = 0.37$, $t = 4.20$, $p < 0.01$), and *FirmPerf* ($\beta = 0.31$, $t = 2.38$, $p < 0.01$). These support the Integration and Service Portfolio Hypothesis (H3), the Integration and Flexibility Hypothesis (H4), and the Integration and Performance Hypothesis (H7).

We also observed positive effects of *CSPC on BusFlex* ($\beta = 0.55$, $t = 6.28$, $p < 0.01$), of *CSPC on FirmPerf* ($\beta = 0.39$, $t =3.03$, $p < 0.01$), and of *BusFlex on FirmPerf* ($\beta = 0.15$, $t = 1.38$, $p < 0.10$). These results respectively support the Service Portfolio and Flexibility Hypothesis (H5), the Service Portfolio and Performance Hypothesis (H8), and the Flexibility and Performance Hypothesis (H6). Finally, effects of the control variable *Firm Size* on *BusFlex* ($\beta = -0.05$, $t =1.47$, $p < 0.10$), and on *FirmPerf* ($\beta = 0.05$, $t =1.34$, $p < 0.10$) are significant and in expected directions, thereby strengthening the overall validity of our results.

Our bootstrap confidence interval analysis further supports our findings. Next, we consider the significance of the test results for the structural model's path coefficients (Table 4). Overall, the model explained ~65 percent of the variance in *CIC*, 72 percent of it in *CSPC*, 78 percent of it in *BusFlex*, and 66 percent of it in *FirmPerf*.

Table 4. Significance Test Results: Structural Model Path Coefficients

Capability Path			H#	Coef	t	p	95% Conf	f^2	Effect
CTC	→	*CIC*	H1	0.81	21.92	0.00	[0.72–0.85]	1.96	Large
CTC	→	*CSPC*	H2	0.33	2.90	0.00	[0.12–0.49]	0.16	Medium
CIC	→	*CSPC*	H3	0.56	5.43	0.00	[0.40–0.75]	0.39	Large
CIC	→	*BusFlex*	H4	0.37	4.20	0.00	[0.23–0.52]	0.22	Medium
CSPC	→	*BusFlex*	H5	0.55	6.28	0.00	[0.40–0.69]	0.47	Large
BusFlex	→	*FirmPerf*	H6	0.15	1.32	0.09	[–0.03–0.34]	0.02	Small
CIC	→	*FirmPerf*	H7	0.31	2.38	0.01	[0.09–0.51]	0.09	Small
CSPC	→	*FirmPerf*	H8	0.39	3.03	0.00	[0.17–0.60]	0.11	Small

Also, R^2 for *BusFlex* is greater than 75 percent and moderate for the other endogenous variables.

In addition to evaluating the R^2 values of the endogenous variables, we assessed the *effect size,* f^2. This measures the change in R^2 when a path is omitted from the model. The relationships between *CTC* and *CIC* (f^2 = 1.96), *CIC* and *CSPC* (f^2 = 0.39), and *CSPC* and *BusFlex* (f^2 = 0.47) all evidenced a large effect size. The relationships between *CTC* and *CSPC* (f^2 = 0.16) and *CIC* and *BusFlex* (f^2 = 0.22) had medium effect sizes from 0.15 to 0.35. Finally, the relationships between *CSPC* and *FirmPerf* (f^2 = 0.31), *CIC* and *FirmPerf* (f^2 = 0.11), and *BusFlex* and *FirmPerf* (f^2 = 0.02) all had small effect sizes.

Examination of the effect size enabled us to assess the relative importance of the significant relationships. Our results suggest that the path, *CTC* → *CIC* → *CSPC* → *BusFlex*, is more important than the other paths in the model. Even though the coefficients for the other paths are significant, their relatively smaller sizes in comparison to the coefficients of this identified path may warrant lesser managerial attention. Furthermore, the path with the largest effect sizes corresponds to that which was hypothesized.[20]

Next, to assess the possibility of *multiple mediation*, we included all of the potential mediators simultaneously and considered the values and significance of their indirect effects. We also compared the indirect effects with the direct effects (Table 5).

All mediating relationships were significant at $p < 0.05$, except for *CSPC* → *FirmPerf*. The direct effects of *CTC* on *BusFlex* and *FirmPerf* were significantly smaller than the indirect effects through *CIC* and *CSPC*, thereby suggesting complementary mediation, wherein the direct and indirect effects are significant and point in the same direction [31]. This further strengthens our argument that, while firms may be able to derive some benefits from cloud technological capability alone, the way to leverage the cloud for firm performance lies in activating the sequential linkages identified in our model. The mediation analysis supports our finding that the path corresponding to the cloud integration model has larger effect sizes and coefficients than others that might be constructed, which emphasizes the greater relevance of this path.

Table 5. Analysis and Comparison of Direct and Indirect Effects

Capability Path			Direct Effect	Indirect Effect	Signif	Larger Effect	Mediation?
CTC	→	*CSPC*	0.33	0.45	$p < 0.05$	Indirect	Complementary, Partial
CTC	→	*CIC*	0.81	—	—	Direct	—
CTC	→	*BusFlex*	0.26	0.73	$p < 0.05$	Indirect	Complementary, Partial
CTC	→	*FirmPerf*	0.26	0.66	$p < 0.05$	Indirect	Complementary, Partial
CIC	→	*CSPC*	0.56	—	—	Direct	—
CIC	→	*BusFlex*	0.37	0.31	$p < 0.05$	Equal	Complementary, Partial
CIC	→	*FirmPerf*	0.31	0.31	$p < 0.05$	Equal	Complementary, Partial
CSPC	→	*BusFlex*	0.55	—	—	Direct	—
CSPC	→	*FirmPerf*	0.39	0.08	$p < 0.10$	Direct	Complementary, Partial
BusFlex	→	*FirmPerf*	0.15	—	—	Direct	—

Our hypotheses were supported, but the effect sizes for some linkages need inspection. The linkages for *CTC* → *CIC, CIC* → *CSPC*, and *CSPC* → *BusFlex* had larger effect sizes. This suggests an appropriate way to leverage cloud technologies for firm performance lies in activating the linkages for *CTC* → *CIC* → *CSPC* → *BusFlex* → *FirmPerf*. This is the *strategic value appropriation path* in our model.

Robustness Assessment Using Orthogonalized Variables

We observe that the correlation between latent variables in our model is relatively high (Table 6). Although PLS is robust against multicollinearity between latent variables [11], to assess the robustness of our results, we also ran *ordinary least squares* (OLS) regression models after orthogonalizing the variables using the modified Gram-Schmidt procedure [71]. This technique subtracts the vector from its projection, resulting in orthogonal variables. An *orthogonalized variable* is one involving the independent variable minus the linear influences of variables upon which it is orthogonalized. This removes the effect of, or partials out, the common variance between variables, creating transformed variables uncorrelated with one another. Similar to research that uses orthogonalization [74, 75], we tested the

Table 6. Correlations between the Second-Order Constructs

	2ND-Order Construct	1	2	3	4	5
1	*FirmPerf*	1.00				
2	*BusFlex*	0.73	1.00			
3	*CSPC*	0.76	0.84	1.00		
4	*CIC*	0.75	0.80	0.81	1.00	
5	*CTC*	0.75	0.79	0.77	0.78	1.00

findings' sensitivity by running regression models with orthogonalized latent independent variables.

We ran OLS models because the orthogonalized variables in the PLS model resulted in a small amount of explained variance for the intermediate latent variables (e.g., *CIC*). This happens because PLS applies OLS regression [15], and orthogonalizing multiple constructs in a full PLS model leads to correlations that come close to 0 between all the transformed variables in a structural path. Thus, the modified Gram-Schmidt procedure, when applied to our full PLS model, results in uncorrelated estimates of the dependent variable with the independent variables, and, therefore, it results in lower variance explained. Conversely, high correlation values between latent variables in PLS estimations are not uncommon (e.g., see Morgeson et al. [60]), and our model does not suffer from multicollinearity; therefore, such values do not adversely affect our estimates.

Table 7 shows the regression results after orthogonalization. Column 1 has a positive coefficient of *CTC* on *CIC* (β = 0.77, p < 0.01), supporting the Technology and Integration Hypothesis (H1). Column 2 has positive coefficients of *CTC* (β = 0.19, p < 0.01) and *CIC* (β = 0.81, p < 0.01) on *CSPC*, supporting the Technology and Service Portfolio Hypothesis (H2) and Integration and Service *Portfolio* Hypothesis (H3). Similarly, Column 3 shows positive coefficients of *CIC* (β = 0.21, p < 0.01) and *CSPC* (β = 0.83, p < 0.01) on *BusFlex*, supporting Integration and Flexibility Hypothesis (H4) and Service Portfolio and Flexibility Hypothesis (H5). Finally, Column 4 has positive coefficients of *BusFlex* (β = 0.73, p

Table 7. Robustness Test: Regression Results Using Orthogonalized Variables

	CIC	*CSPC*	*BusFlex*	*FirmPerf*
Variables	Model 1	Model 2	Model 3	Model 4
Cloud Technological Capability (*CTC*)	0.77*** (0.05)	0.19*** (0.05)	—	—
Cloud Integration Capability (*CIC*)	—	0.81*** (0.05)	0.21*** (0.04)	0.16*** (0.05)
Cloud Service Portfolio Capability (*CSPC*)	—	—	0.83*** (0.04)	0.27*** (0.05)
Business Flexibility (*BusFlex*)	—	—	—	0.73*** (0.05)
F-stat.	37.29***	43.59***	63.09***	28.70***
R^2	0.64	0.70	0.77	0.63
p-value for *F*-test: *CIC* coef. > *CTC* coef.	—	p < 0.01	—	—
p-value for *F*-test: *CSPC* coef. > *CIC* coef.	—	—	p < 0.01	—

Notes: N = 147; standard errors in parentheses; signif.: *** p < 0.01, ** p < 0.05, * p < 0.10; coefficients of control variables and constant omitted for brevity. For Models 2-4, each independent variable is orthogonalized on each of the other independent variable constructs as in prior research [71, 74, 75]. For example, in Model 4, each of *CIC, CSPC*, and *Business Flexibility* are orthogonalized on each other. For Model 1, *CTC* was orthogonalized on the control variables.

< 0.01), *CIC* ($\beta = 0.16$, $p < 0.01$), and *CSPC* ($\beta = 0.27$, $p < 0.01$) on *FirmPerf*, supporting the Flexibility and Performance Hypothesis (H6), Integration and Performance Hypothesis (H7), and the Service Portfolio and Performance Hypothesis (H8). Thus, the hypotheses are supported with orthogonalized variables in the regressions, suggesting the relatively high correlations among the latent variables in the PLS model are not a problem.

We also conducted a proxy test for the *strategic value appropriation path* in the regression models using orthogonalized variables. For this, we used *F*-tests to compare the respective regression coefficients. In Column 2, we find that the coefficient of *CIC* is significantly higher than the coefficient of *CTC* ($p < 0.01$). In Column 3, the coefficient of *CSPC* is higher than the coefficient of *CIC* ($p < 0.01$). These findings support our PLS model findings regarding the *strategic value appropriation path*. Regression results of the unorthogonalized variables (omitted for brevity) are similarly consistent with the PLS results. Overall, the regression results using orthogonalized variables strengthen our findings.

Discussion

Overview of Key Findings

Our objective was to propose and validate a theory and a research model that yields managerial guidance based on a rigorously-specified theoretical foundation. We adopted a holistic yet fine-grained view of cloud implementation for the creation of business value in organizations. This study is pioneering in operationalizing and testing the main tenets of cloud models, which represent the means to appropriate strategic value for the organization. Through the cloud literature, and the dynamic capability hierarchy and operand-operant perspectives, we identified constructs that underlie a set of hypothesized linkages to explain its value-creating capacity, building on recent works on readiness assessment for cloud adoption [40].

Our work uncovered multiple capabilities involving cloud integration and service orientation that support the creation of business value from the cloud platform. We tested a set of set of sequential relationships relationships for cloud technology, integration and service capability, business flexibility, and firm performance. Our findings suggest that the synchronization and consistency capabilities of cloud computing yield a firm's cloud-enabled services portfolio capability. This, in turn, leads to business flexibility and performance. Our results also hint that cloud models must evolve from an artifact-focused view to an integrative, service-oriented view. Embedding such considerations in cloud-based strategies will improve firm performance.

Our results further suggest that the firm may benefit most when it moves along the most-desired *strategic value appropriation path*, which is an important new revelation. This path in our cloud integration model is a finding with a high surprise value: we did not hypothesize the possibility that such a path might have the greatest statistical effect, yet still, we observed it. Future work can build on this finding by identifying and testing mechanisms to explain why this path may be beneficial in business value creation from cloud technology in a firm. Such analyses may entail use of other interdisciplinary qualitative and quantitative methods such as case studies or sector studies, and new opportunities are emerging in this area.

Cloud-based technology deployments can help firms by enhancing, extending, and redefining their physical and traditional products and services through an integrative approach. Value creation from cloud computing can be attributed to its ability to reshape the value propositions that customers will benefit from, and yield improved performance and revenue streams for organizations.

Some of these aspects of cloud-driven performance are seen in just-in-time access and service delivery, like the Internet channel for streaming movies and music. Recent digital transformation involving mobility and social media have created impetus for firms to adopt cloud-based services to address issues with customer expectations and to deliver on value propositions. Some consumer-focused industries are expecting a shift toward creation of more digital content with higher service digitization, and deeper, more comprehensive digital processes as a result [73, 81]. Managing them with third-party service and cloud platforms will be challenging due to the lack of standards and interoperability. The most popular approaches involve co-creating new services, applications, and content through alliances. Our findings suggest that, by building service-oriented and integrated cloud platform capabilities, firms will realize the potential value of cloud computing with a service-oriented approach [4, 22].

Contributions to Research

This study offers several contributions to IS research. First, it adds to the sparse cloud business value literature. There are few research studies that examine cloud computing from a business perspective, as this space has been dominated by a focus on technological issues. By identifying key cloud capabilities, our study contributes to a deeper “understanding of the interplay between cloud capabilities and its transformative value” in the spirit of the earlier research.

Second, our study contributes by applying recent advances in operand–operant resource and capability hierarchy thinking for cloud computing. It highlights how different types of operant resources need to be developed in the pathway for cloud computing value creation. This informs IS researchers in a meaningful way: cloud computing is not just about infrastructure changes. The combinations of cloud capabilities are the most important factors. An implication for IS research is to apply operand–operant resource concepts to other areas. For example, there is a need to examine the role of IT as an operant resource in areas of product and service innovation [62], which is a promising direction.

Third, our study suggests that there is a *strategic value appropriation path* from cloud implementation to value creation. Our work delivers on the need to examine paths from

IT capabilities to economic value. Our finding of such a path for cloud technology contributes to developing theory for "what are the indirect paths to economic value that can be influenced by information and IT capabilities" [43, p. 29]. It moves the research forward to identifying and testing mechanisms that explain how to make it feasible for firms to follow this path so as to further enhance business value creation using cloud technologies. It will be beneficial to reconsider the kinds of contexts that we studied by developing more fully an approach to empirical research inquiry that more comprehensively assesses sequential dependence as well as intertemporal causality.

Fourth, our study fills the gap in research on cloud integration with legacy systems. Our findings stress that cloud integration with legacy systems is an important means for service capabilities, business flexibility and performance to be enabled. The broader IT governance literature has used cloud computing as an exemplar of modular architectures that enhance business outcomes [16, 93]. Our approach to cloud capabilities provides insights into how and when such architectures create benefits.[21]

Implications for Practice

Our study has four practical implications. First, as technologies mature, cloud-enabled organizations and their embedded systems will have a salient role in driving business, so the benefits of service-oriented cloud solutions need to come together [88]. This has been difficult, in part because it is a *business-oriented*, not a *systems-oriented approach*. Current systems are framed around shifting of loads from local systems to remote servers and enabling an access, control, and monitoring mechanism to serve local system users. Practitioners' understanding of the business view of cloud computing, as well as key services and service-enabled functions that can be enabled through this shift, are limited. Our study contributes new foundations for understanding how to reliably appropriate value from cloud computing.

Our model complements existing viewpoints that explain cloud performance from an operational and technology-oriented perspective. Prior studies examined cloud performance through metrics such as system availability, reliability, response time, bandwidth, and latency. Indeed, much of the motivation for cloud adoption is based on these performance metrics or on *cost arbitrage*—by reducing the recurring costs of engineering, management, and support activities—plus physical infrastructure. These dimensions are surely important, but practitioners understand less regarding how cloud computing can be reoriented to achieve service delivery and business process alignment for better firm performance. Our study suggests that by achieving consistency and synchronization between cloud and legacy data and functionality, firms can ensure that data from legacy systems (e.g., ERP) are available to users (e.g., salespersons) anywhere and flexibly via the cloud. This makes firms' business processes that are impacted by the cloud (e.g., sales) more adaptable for change. This is due to scalability and elasticity of cloud systems to keep up or align with changing business processes. Other business outcomes may include considerations such as customer satisfaction due to cloud services.

Finally, we find that cloud capabilities can be leveraged for service-oriented decision support, and extending the firm's service portfolio. For instance, for business intelligence and analytics using cloud computing resources, it is increasingly recognized that they are appropriate for data processing as well as for next-generation analytical applications. The information exchanged with legacy systems can enable the firm to expand its service portfolio by helping managers to understand their business better and support timely decision-making. This strengthens the organization's potential for designing and developing innovative data, information and analytics services faster and more effectively.

Our finding related to the *strategic value appropriation path* offers rich guidance to practitioners. Our results suggest that managers need to track and develop an appropriate and effective set of capabilities such that the implementation of cloud computing will lead to the firm's appropriation of business value. The findings reveal the relative importance of different intrafirm actions that will help to create the appropriate service operations "sockets" that the firm can use to activate the transformation of cloud computing services to create business value for the firm. We note that not all cloud computing-related capabilities are created equal in business value terms. Each of the capabilities may differentially support value appropriation. We further suggest that it may be apt to undertake a "3M strategy" to *measure, monitor and manage* cloud computing implementation such that there are no major roadblocks in a capability area that causes some diminution of the potential for value appropriation. Finally, our results indicate the importance of exploring new ways to tailor our value appropriation path-related constructs so the method will be robust to application in different business sector and operating contexts.

Overall, our results further imply: (1) the constructs that we identified are informative and useful for practice; (2) the ideas related to the operand-operant hierarchical resources of cloud computing offer a useful basis for inventorying organizational capabilities to appropriate value from the implementation of cloud computing; and (3) if there is a sense in a firm that value appropriation from cloud computing is less than best, the understanding gained from the model we tested will help assess the steps needed to improve performance supported via cloud resources and capabilities.

Limitations and Future Research

Although our work is based on strong theory, the cross-sectional nature of the empirical analysis hinders causal testing of intertemporal dependence, even though the basic capabilities are clearly required as the basis for forming other capabilities that develop from them (e.g., *Cloud Technological Capability as a basis for Cloud Service Portfolio Capability, and also for Cloud Integration Capability, and similarly for latter capabilities as a basis for Business Flexibility*). In particular, our design does not permit causal inferences to be made along the *strategic value appropriation path*. We call for further studies to assess sequential causality and generalize the work that we have done to pioneer the use of a model for value from cloud computing. Second, the Indian firms in our sample were small and relatively new; they are hardly the complex organizations one thinks of as the kinds of firms that will likely benefit from cloud computing in the long run. Our results may not generalize to firms of all sizes. To address this, we conducted post-hoc analysis of how the focal constructs differed across firm size and age.[22] The absence of statistical relationships suggests that these variables do not appear to bias the results. Finally, our study was done in India, where IT advances are somewhat less than that in developed economies, although growth is higher. This limits generalizability across nations.

As more firms embrace cloud computing, future research can study how to accommodate emerging capabilities, such as crowdsourcing, business analytics, and machine intelligence support, to build synergy, deliver innovative and reliable cloud-based services, and create consistently high value. We encourage capability research on how to integrate cloud and non-cloud systems with business model innovations for processes that need to be integrated so fuller compatibility and interoperability can be achieved.

Also, a prime study topic is how the relationships between cloud operant resources and a firm's digital capabilities vary across different settings in which cloud technologies are applied. In addition, although our study identifies and tests a set of cloud capabilities, we recognize that this set of capabilities is not exhaustive of the entire domain of cloud computing. Future work can examine other cloud operant resource capabilities as mediators or moderators and other business outcomes. Such a research agenda may shed light on how firm contexts create limits-to-value for cloud computing, and how to overcome them.

Furthermore, this study was conducted in the context of client firms using cloud technologies without examining the vendor side. Future research can examine issues related to cloud value appropriation from the perspective of cloud client vendor exchanges, as Retana and colleagues [69] have done. Finally, it will be worthwhile to examine resource capabilities that offer potential theory to explain the gains from cloud computing. For example, cloud operant resources related to security management may help achieve better information security outcomes. Other business outcomes may include innovation and collaboration.

Conclusion

Cloud computing is an evolving field, and the lack of standards and interoperability creates ongoing challenges for organizations in deriving value from its implementation. We offer three takeaways as beacons for research and practice to understand how cloud computing can support performance enhancements.

Our study suggests a need for a systems-oriented approach to maximize the benefits from cloud computing. The focus should be on exploring interdependencies between different organizational capabilities and their development, instead of just focusing on utilizing the technological advantages of the cloud infrastructure. This study uses one such perspective for exploring the interdependencies between the capabilities by looking at their hierarchical relationships. However, because of the diversity, complexity and uncertainties in cloud computing, there may be other combinations of cloud-enabled organizational capabilities that will support appropriating business value from cloud computing.

This study also provides guidance to practitioners for overcoming design, delivery, operational, and integration issues by identifying a *strategic value appropriation path* for leveraging the cloud. This path may become more germane in light of technological advancements, such as fog computing. It is likely that the *strategic value appropriation path* is not without obstacles. We call for research to study how firms can follow the *strategic value appropriation path* while overcoming the inevitable obstacles.

Finally, the key cloud capabilities we noted provide opportunities for developing a richer agenda for IS researchers in this area. Follow-on work will open up a new, less distant horizon of opportunities in cloud use and management. This gives us a chance to study firm, market and economy-level processes that will drive transformation. To achieve the bright prospects on offer, researchers must develop new ways to partner with organizations. We can bring the newest research inquiries, and most effective theoretical and data analytics approaches, to understand how the cloud will change firm performance. Bringing together theory perspectives, analysis approaches, and data analytics advances from the organizational, economic and technical disciplines will open up new ways to make research on cloud computing scientifically strong and exceptionally meaningful. Together with other articles in this special issue of Journal of Management Information Systems, it is interesting to travel on a road to the future of cloud computing research which our community is collaboratively paving.

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Supplemental Material

Supplemental material for this article can be accessed on the publisher’s website.

NOTES

1. Our *resource-based view* (RBV) of cloud computing is consistent with prior cloud computing research [28]. See Barney [3] for a review of RBV theory, and for RBV theory in IS research, see Wade and Hulland [89].

2. Madhavaram and Hunt [53, p. 70] state that "what a researcher might label as a "composite, operant resource" in one schema might be considered as a basic operant resource, a building block, in another schema." Similar schematic representation differences may exist for different cloud integration or service conceptualizations. Our objective is to validate a model for cloud computing as a *resource hierarchy-based, service-oriented value-creation strategy* that is novel yet granular. There is still quite a bit of scope to conceptualize operant resource hierarchies differently though.

3. Service offerings can result from or be supported by the provision of computing capabilities, such as dynamic on-demand allocation of server time and network storage, automatically without human interaction by the provider. Cloud resources also are pooled to serve multiple consumers using a multitenant model [93, 94], with dynamic resource assignment.

4. Business execution through cloud mobile platforms can support rich mobile applications and an engaging user experience. When a retailer opens a mobile store front, it needs to enable cloud services for secure mobile payments through a cloud-enabled mobile payment gateway system that allows it to connect with other market participants. This is more of a market orientation than a service orientation though. Other characteristics that enable cloud market offerings are interoperability, compatibility, and collaborative or complementing services across a variety of systems.

5. Our hierarchical taxonomy of cloud computing capabilities is illustrated for hybrid cloud adoption by EasyJet, a leading European low-fare airline [70]. EasyJet utilized cloud-based services offered by Microsoft Azure to enhance its existing on-premises registration system by adding a cloud-based seat allocation solution. For successful deployment, it was fully integrated and synchronized with its legacy system to be able to appropriate the benefits of the cloud implementation. EasyJet got a flexible, scalable infrastructure it can use to introduce new features quickly, enhancing its service portfolio and creating value.

6. Jindal Steel and Power, a steel and energy provider in India, is an example of a firm that effectively integrated cloud-based auction systems with its existing legacy systems to support better business decisions and improve execution efficiency in inventory management across its various warehouses [26, 44]. This example suggests that to achieve transformation and value-creation from cloud computing, a firm must go beyond cloud technology and architecture to create fully-integrated cloud capabilities that enable alignment of cloud service functionality with other systems. Cloud technology may be an enabler but will not suffice to achieve outcomes for a supply chain business function, without integration of the cloud platform.

7. Elasticity and on-demand provisioning of cloud resources are beneficial because services experience seasonal and periodic demand variation. Their value shows up in reduced time to introduce, deploy, and develop new services; maintain existing services; procure hardware and software platforms; and avoid the cost of higher use and reuse of existing resources. For example, cloud technology capabilities enabled Art-World [45] (a company that connects art dealers to collectors) to rapidly deploy and scale its service offerings through reliable, scalable, and dynamically-allocated IT resources. Another example is the photo website, SmugMug. Cloud technology capabilities have allowed it to meet demand spikes during the two months of the year when demand goes to five times the usual load [56].

8. Complexity in cloud utilization is present because of multiple deployment models (public, private, hybrid cloud), service options (SaaS, IaaS, etc.), and utilization choices (fully cloud, legacy-based, or a hybrid mix). In most firms, IT departments lead the implementation, test the delivery model and develop the capabilities to manage distributed implementation. Functional areas often adopt cloud functionality independently for quicker implementation and may adopt without prior approval.

9. A reason for the incompatibility of cloud service providers is that the cloud market is developing. No single vendor has a dominant position, especially for small and medium enterprises. Most enterprises use services from disparate vendors.

10. Synchronization of data across cloud and legacy systems is achieved via mechanisms such as transaction and application handoffs using transaction coordination, central authentication, control and change management, and standardization apps.

11. *CIC* enabled the governing council for technical education in India to develop *CMOC* by using streamlined data sharing across cloud offerings to support collaborative research across various institutes under its umbrella and with partner institutions [21].

12. Apeejay Stya and Svrán Group, an Indian conglomerate, serves as an exemplar for *CIC* leading to *BusFlex*. Integration of cloud-based systems with other systems helped the group to gather information from a variety of sources, and improve flexibility of its business processes and efficiency of its operations [2].

13. Dr. Lal Pathlabs, an Indian healthcare company, is example of how effective integration increases access of key ITs and scale economies for technical resources. The firm effectively integrated a cloud-based patient registration system with its resource planning system to increase efficiency by 15% [9].

14. India is the world's fastest growing major economy. Business flexibility, responsiveness, and scalability are competitive priorities for firm performance and survival in India [39]. The growth of cloud services has resulted in the big providers setting up data centers there. Microsoft set up three Azure data centers to cater to new demand [79]. Meanwhile, public cloud computing services reached US$731 million in 2015, with cloud management, SaaS, and IaaS slated to reach US$1.9 billion in 2019 [34].

15. We are interested in measuring cloud capabilities and not simply cloud implementation; therefore, a survey is suitable. It allows us to measure nuances of internal firm capabilities more effectively than objective measures of implementation [33]. Similar to prior firm-level IS research [67], subjective measures were used for firm performance as senior managers have reasonable information and perspective of firm performance [47], and differences in accounting conventions and practices can confound comparisons of financial metrics, particularly in emerging markets such as India where accounting procedures are less developed.

16. We took multiple steps to mitigate *common method bias*. We used different scales to measure different constructs. Although use of similar scale formats and anchors requires less cognitive processing, this may increase method bias due to consistency in scale properties. We measured all key constructs using multi-item, 7-point or 5-point Likert scales. Using scales with different anchors reduces common method biases caused by commonalities in scale endpoints and anchoring effects [12, 65]. The 7-point scales were used for constructs when there was a precedent in prior work, while 5-point scales were used for new constructs. This approach benefits from reduced survey weariness for the respondent. Research has precedents for utilizing different scales during data collection and analysis, without reconciliation. To ensure our results are independent of scales, we re-scaled all items to a 5-point scale and reran our analysis. The results were similar and are omitted for brevity. We used a *matched pair design*, ensuring that independent and dependent variables were collected from different respondents in the same firm.

17. We refined our initial questionnaires based on results of the pretest. Pretest respondents filled out prototype questionnaires and were then interviewed and asked questions on their interpretation of the items. They offered comments on content validity, appearance, terminology, clarity of instructions, organization, and response format. We then made adjustments to the questionnaires based on the comments. We conducted a further pilot test with a small sample from the targeted population for reliability, convergent and discriminant validity, and predictability. We then made final revisions for items based on the pilot test results.

18. Firms from which we did not receive responses from both the CEO and CIO were dropped from the sample. The survey was done in-person and, as a result, we could identify who responded; if the CEO and CIO did not respond, their organizations were also dropped.

19. Individuals who answered our survey were acting as agents of their firms and provided responses to firm-level questions. To adhere to ethical principles regarding research-related data collection and to enhance response rates, we did not collect personal information from respondents, such as their demographics or job tenure. This ensured confidentiality and privacy for respondents, who could answer questions free from legal risks and report the actual, rather than the desired state of their firms.

20. We were careful in this research to ensure that the paths in the analysis were established based on appropriate evidence. For example, the importance of the *CTC → CIC → CSPC → BusFlex* path is further supported by a simple mediation analysis that we conducted, which was significant at the $p < 0.10$ level. The *Sobel test* for the *product of coefficients approach* [77] was used to assess the significance of simple mediation relationships. However, recent methods advances in PLS-SEM research suggest that this is not a valid method for assessing mediation in these contexts. First, the product of coefficients approach identifies two types of mediation, whereas recent advances propose three types of mediation and two types of non-mediation, requiring a series of different analyses. Second, the product of coefficients approach was developed for evaluating simple mediation, consisting of a single mediator. Structural models that contain more than one mediator require running a series of separate simple mediation analyses, which leads to biased and inaccurate results [31]. Third, the Sobel test assumes that the data for each of the variables follow a normal distribution, which is inconsistent with PLS. Fourth, the parametric assumptions of the Sobel test do not hold for indirect effects. Fifth, the Sobel test requires unstandardized coefficients as inputs. Finally, the test has low statistical power for small sample sizes. Instead, an alternate method to assess mediation in PLS has been proposed—which we use—in which the sampling distributions for the indirect effects are bootstrapped and multiple mediation analysis is conducted.

21. A minor contribution of this study is the *dual online-offline mode*; to our knowledge, we are the first to employ this method, which is suitable for the unique Indian context. In the future, other researchers can follow this approach to improve authenticity and response rates for primary data collection efforts in India.

22. We conducted a parametric test to compare mature and immature firms with respect to cloud computing technologies. The intuition for doing this analysis is to assess whether the relationships were weaker for immature firms than for mature firms, given that mature firms may have had more time to develop their cloud capabilities. The *t*-tests of standard errors derived from bootstrapping indicate that our hypothesized relationships are weaker (albeit significant) for immature firms. Although this suggests the temporal evolution of cloud capabilities, we note several caveats. The small size of subsamples restricts our ability to draw meaningful implications from such an analysis. Furthermore, this traditional approach is inappropriate for PLS as it suffers from Type I errors and inconsistent distributional assumptions. We are also restricted from employing the nonparametric permutation test or the *PLS-multigroup analysis* (PLS-MGA) technique: our subsamples are not of equal size and limit statistical power to detecting only large-sized effects ($R^2 > 25$ percent). Due to these limitations, we did not add this analysis to our main narrative. Even so, they present an interesting avenue for future inquiry.

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