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Assessing the determinants of cloud computing adoption: An analysis of the manufacturing and services sectors

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ABSTRACT

Many factors influence the adoption of cloud computing. Organizations must systematically evaluate these factors before deciding to adopt cloud-based solutions. To assess the determinants that influence the adoption of cloud computing, we develop a research model based on the innovation characteristics from the diffusion of innovation (DOI) theory and the technology-organization-environment (TOE) framework. Data collected from 369 firms in Portugal are used to test the related hypotheses. The study also investigates the determinants of cloud-computing adoption in the manufacturing and services sectors.

1. Introduction

Large and small enterprises are rapidly reorienting their overall information technology (IT) strategies to include cloud computing. As the strategic emphasis on flexibility, innovation, and economic gains increases, organizations can no longer overlook the advantages of the computational agility and scalability provided by a distributed cloud-computing environment [5,36,16]. With the potential to transform business processes, lower IT expenditures, deliver real-time applications, offer access to ubiquitous storage, unlimited computing power, and market information mobilization, organizations look to cloud-based solutions to achieve business efficiencies [16,65,100,6,37]. Thus, companies are seriously considering increasing IT expenditures on cloud computing [30].

Despite the touted advantages of this new technology, evidence suggests that not all companies are rushing to adopt cloud-based solutions [1,105]. Among the reasons are that it is a disruptive technology that has not reached a level of maturity; the lack of industry-specific conformity to standards; and a high level of related risk and costs [9,12,70]. In addition, firms in certain sectors may have only a modest investment in technology. Examples include small and medium enterprises (SME) in supply chain-centric industries such as manufacturing, agriculture, and construction [1]. They have limited technical capabilities and often rely on smaller groups of IT professionals or contract IT staff for their IT needs. The reluctance to adopt cloud computing solutions, a disruptive technology in the "technology trigger" or the "inflated expectations" phase of the hype-cycle [30,38], are therefore real and noteworthy.

Clearly, the cloud phenomenon is not a panacea for all organizations. The purpose of this study is to understand the determinants of the adoption of cloud computing and its relative advantage to organizations. Most earlier studies on cloud computing have focused on technical and operational issues [119]. A few studies have addressed the adoption of cloud computing from an organizational perspective (see Table 1), mostly assessing the direct effects of the innovation characteristics or the contextual factors. No study has conducted a holistic evaluation of the direct effects and the indirect effects of the determinants on cloud-computing adoption. Motivated by these issues, this study seeks to develop a research model that integrates the innovation characteristics [91] of cloud computing and the technology-organization-environment (TOE) perspectives [104] that underlie its adoption. The contribution of the article is twofold. First, to investigate the direct and indirect effects of the innovation characteristics and the TOE contexts on the adoption of cloud computing, data from 369 firms in Portugal are used to evaluate the research model. This study therefore presents a more

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Table 1
Cloud computing studies published in peer reviewed journals.

IT adoption (dependent variable)	Adoption theory	Constructs/factors (independent variables)	Methods	Data and context	Author
Cloud computing	TOE and DOI	Technology (relative advantage, complexity, compatibility), organization (top management support, firm size, technology readiness) and environment (competitive pressure, trading partner pressure)	Factor analysis (FA), logistic regression	E-mail survey of 111 firms belonging to the high-tech industry	[65]
Cloud computing	TOE	Technology (relative advantage, complexity, compatibility), organization (top management support, firm size, technology readiness), and environment (competitive pressure, trading partner pressure)	Conceptual	Conceptual model	[1]
Cloud computing	IPV and DOI	Business process complexity, entrepreneurial culture, compatibility, application functionality	Confirmatory factor analysis, multiple regression analysis	E-mail survey of 289 firms in manufacturing and retail	[117]
Intention to adopt cloud computing	TOE	Adopter's style as moderator of: perceived technology barriers, perceived environment barriers, perceived benefits	Partial least squares (PLS)	Using secondary data	[82]
Cloud computing	DOI	Relative advantage, compatibility, complexity, trialability, observability	Semi-structured qualitative interview	19 IT professionals, Taiwan	[60]
Cloud adoption	–	Barriers and benefits	Qualitative and quantitative methodology	Survey of 94 SMEs in Spain	[106]
–	Institutional theory	Regulative, normative, cognitive	Conceptual	–	[54]

Note: Diffusion of innovation (DOI); technology-organization-environment (TOE); information processing view (IPV).

holistic assessment of the determinants of cloud-computing adoption than earlier studies. Second, by investigating the determinants of cloud adoption in two sectors (manufacturing and services), we contribute to the wider body of scientific knowledge that has so far not studied the adoption of cloud computing in these two sectors. Our study highlights the importance of systematically evaluating the determinants of cloud computing at the industry level.

Through a review of the literature, we provide background on cloud computing and related research. We then describe the theoretical foundations for the research model and propose the hypotheses. The research methodology and the results are presented, followed by a discussion of the major findings. We conclude by highlighting the implications of the findings and summarizing options for future study.

2. Background

2.1. Cloud computing

There is no universal or standard definition of cloud computing [100,35,40,120,71], even though it is not a completely new concept. Cloud computing evolved through the recent advancements in hardware, virtualization technology, distributed computing, and service delivery over the Internet. The "cloud" metaphor is a reference to the ubiquitous availability and accessibility of computing resources via Internet technologies [100,109]. Cloud-based solutions give businesses and users easy access to massive computing power at negligible costs [116]. By moving IT functions such as storage, business applications, and services to the cloud, organizations can potentially reduce the overall cost of IT [71,41,98]. Cloud computing thus offers monetary benefits that businesses can no longer ignore.

Generally speaking, services offered by cloud computing can be classified into three types [18]. In Infrastructure as a Service (IaaS), the basic units of computing power and storage are cloud-based and available on demand (e.g., Amazon Elastic Compute Cloud (EC2), Rackspace, Amazon Simple Storage Service (S3), and GoGrid). The benefits of this model include pay-per-use and resource elasticity to match the computing demands [103]. In Platform as a Service (PaaS), the service provider offers an integrated solution stack for creating and deploying applications from the cloud (e.g., Salesforce, Google AppEngine, and Microsoft Azure). An advantage of this model is the ability to provide all aspects of software development (design, testing, version control, maintenance, and hosting) over the Internet [98]. In Software as a Service (SaaS), users access the applications centrally hosted in the cloud using a thin client (such as a web browser or a mobile application) instead of installing software on their own computers (e.g., Joyent and SalesForce CRM). The benefits of this model of cloud service include centralized configuration and hosting, software release updates without requiring reinstallation, and accelerated feature delivery [31].

Cloud computing represents the convergence of IT efficiency and business agility [51]. IT efficiency results from the use of scalable hardware and software resources [71], improvement in work efficiency and coordination among firms [65], and highly available services [6]. The business agility of cloud computing is the ability to deploy computational tools rapidly, reduce upfront capital expenditures [71,59], and respond more quickly to changing market needs [6,71]. Cloud computing eliminates traditional boundaries between businesses. The capacity to seamlessly deliver IT functions as cloud-based solutions has proven viable and cost-effective as evidenced by its growing adoption.

2.2. Adoption models

Two theories are commonly used in innovation diffusion and adoption studies in organizations. They are the diffusion of innovation (DOI) theory [91] and the TOE Framework [104]. Other popular theories such as the technology acceptance model (TAM) [27,28], the theory of planned behavior (TPB) [2], and the unified theory of acceptance and use of technology (UTAUT) [108] are not considered in this research because they pertain to an individual's choice.