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# The Impact of Knowledge Engineering and Cloud Computing Adoption on Business Driven IT

Tarek Kaddoumi, Khaled Elhabashy, Mohamed Diab, and Mohamed K. Watfa

**Abstract**—Organizations have high expectations for cloud computing to help them in accomplishing their Business Level Objectives (BLOs) and consequently change the landscape of the business boosting both the flexibility and the agility of the business processes. Cloud computing improves management availability by monitoring the operations and creating new virtual environments for a multiplex set of ubiquitous services which is also referred to as the Internet of Things. Business Driven IT Management (BDIM) is a way to manage business layers through business metrics that are aligned with IT metrics through a processes layer. This paper analyses the linkage between cloud computing and the BDIM metrics including organization’s cost, quality of service (QoS), and productivity. Some of the research questions that would be analyzed include the following: will the cloud be cost efficient? Will it affect business productivity? Or will it enhance the quality of services?

**Index Terms**—Knowledge engineering, cloud computing, bdim, quality of service, productivity, cost efficiency.

## I. INTRODUCTION

Will cloud computing be of benefit to businesses? What are the advantages that businesses would expect from cloud computing for retaining the desired competitive advantage and to compete in the industry? These questions are being asked by many stakeholders. The integration of cloud computing into business processes is an important topic nowadays, as cloud computing is changing the way to deliver IT and business services. Technology must support businesses to become virtual allowing them to manage complex ecosystems of cloud providers. Cloud computing has significant impacts on existing businesses, including customer experience. Also, the means the cloud is changing the technology used in supply industry forces the vendors to raise the IT service quality and corresponding level of service competency. Another evident impact of cloud computing on business processes is the shifting of IT based products to business services. The reason of adopting cloud computing is not just cost reductions but also the increased customer preferences in innovative business processes.

The rest of this paper is summarized as follows. In Section II, we provide a detailed review and analysis of the existing work that discuss the definitions, the challenges of cloud computing, the BDIM model, and the factors that affect the organizational flexibility to adopt cloud computing. In

Section III, we present our proposed research framework and data collection overview. In Section IV, we analyze our data and provide some reasoning behind the results including hypothesis testing. We conclude this paper in Section V.

## II. LITERATURE REVIEW AND RELATED BACKGROUND

A number of research publications have discussed various definitions and implementations of cloud computing. For example, Keshavarzi, Haghghat, & Bohlouli [1] provided a definition for cloud computing, and discussed associated challenges. They reviewed more than sixty-five definitions for cloud computing and categorized the research challenges and directions into six groups: 1) Security, 2) Autonomic Resource Management (ARM), 3) Cloud Adoption, 4) Cloud development and benchmarking, 5) big data technologies and cloud computing, and 6) social clouds. They also concluded that security is the most common challenge in the field of cloud computing. Additionally, Fitó & Guitart [2] discussed designing and implementing self-management systems of cloud computing entities, specifically the cloud services and infrastructures that are aware of the organization Business Level Objectives (BLOs). They claimed that the best business model to ensure the linkage between the IT management & BLOs is a business-driven IT management (BDIM) because it has evolved as the most promising way of aligning IT management decisions with business objectives coming from the providers themselves, as well as from their users. They signified several challenges on the cloud computing paradigm such as the balancing between IT infrastructure Quality of Service (QoS) and the business results, managing and monitoring different providers involved in this multi-cloud scenario, especially, if there are outsourced providers.

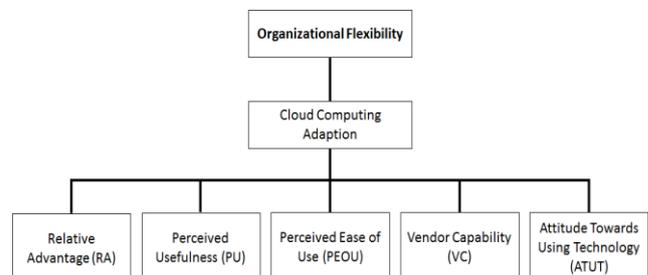


Fig. 1. Conceptual model for cloud computing adoption to achieve organization flexibility.

Bharadwaj & Lal [4] summarized the role of information technology services (as shown in Fig. 1) such as cloud computing adoption drivers, which are embedded in every business processes, which could not be denied to apply the organizational flexibility. This adoption is based on applying

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some factors e.g. relative advantage, perceived usefulness, perceived ease of use, vendor credibility and organization's attitude towards using technology. Applying these IT technologies helped organizations in restructuring their business processes, creating new markets, improving customer satisfaction, in addition to achieving their business goals and improving their utilization of business resources to obtain higher throughput.

Businesses apply cloud computing through some models such as Software as-a-Service (SaaS), Platform-as-a-Service (PaaS), and Infrastructure-as-a-Service (IaaS), but applying the cloud computing could be different from country to country upon their geographical location and their industry structure. Some researchers found that applying SaaS has significant impact in small and medium organizations, and it depends on some factors such as confidentiality, access and authentication, however some others viewed the cloud from the perspective of cost and Return on Investment (ROI). For example, according to Rogers [3], there are some factors that can affect the organization's decisions; these factors have been implemented from diffusion of innovation theory, this is the power of the cloud to innovate business models to reduce cost and time, but applying cloud computing in business can be adopted when technology is widely used; however applying the new technology depends on some factors, those are:

- 1) **Technology Acceptance Model (TAM):** proposed by Davis theories. The model concludes that perceived usefulness (PU) and perceived ease of use (PEOU) can be applied when the individuals believe that applying these new technologies can improve the business, and will enhance the individual's performance, reduce their efforts.
- 2) **Vendor credibility:** This is applied when customers believe that the organization can be trusted to give IT applications choice flexibility according to the customers' needs.
- 3) **Contingency Theory:** that addresses the support from the top management to ensure that the availability of resource is adequate and will be used in innovation.
- 4) **Attitude towards Using Technology (ATUT):** there are some factors used to identify the organizational attitude toward using the new technology.

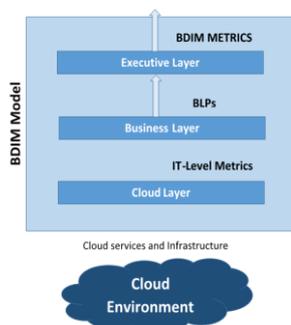


Fig. 2. BDIM model architecture.

Rogers [3] elaborated by summarizing that PU and PEOU are important factors to apply decisions regarding cloud services, moreover applying the top management support is very important in innovation because it is reflecting the

reliability and security trust that may need in some cases to reengineer the business process to gain the customers satisfaction.

From the literature review outlined before, the BDIM model (depicted in Fig. 2) was proposed to be used by any cloud provider driven by BLOs to support the organization core operations management. This model is generic and adaptable to be used by any business driven cloud provider.

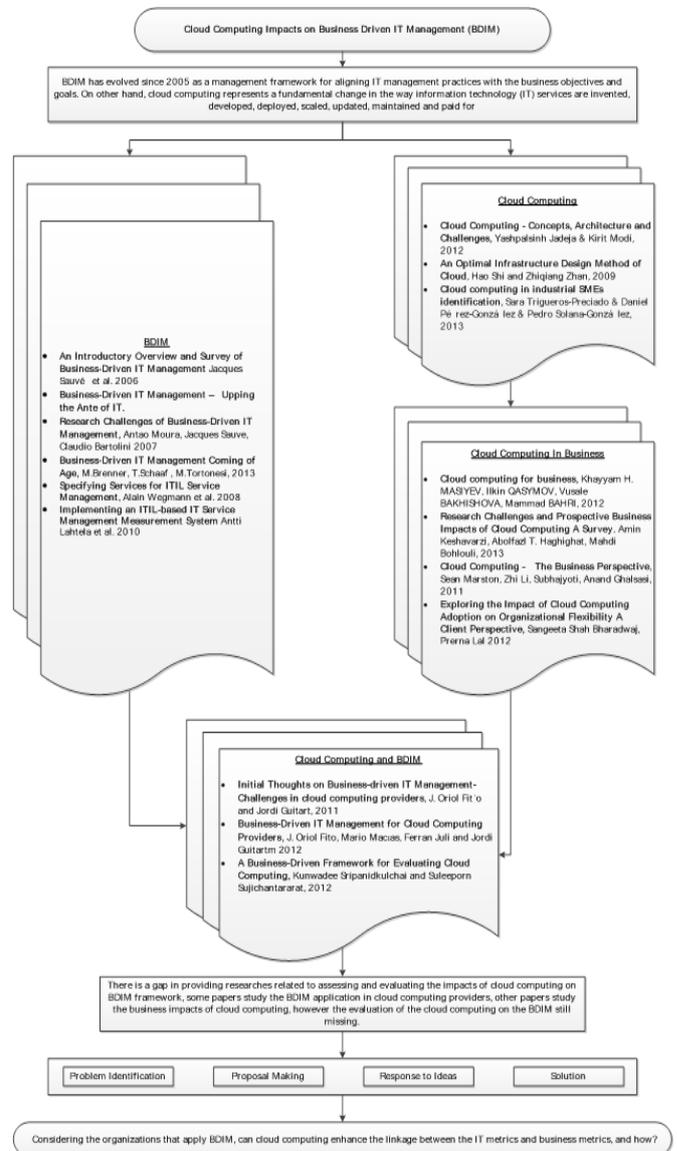


Fig. 3. Cloud computing & BDIM literature review map.

The model consists of the following three layers:

- **Cloud Layer:** A virtual independent-platform monitoring system to monitor the cloud services and infrastructure, and the IT-level metrics concerning both services deployed on the provider and the underlying federated infrastructure used. This kind of monitoring tool is required to be able to control the use of resources from third-party providers.
- **Business Layer:** Models the changes of BLPs - (such as revenues or losses, energy efficiency, risk and trust) - that caused by the IT-related metrics monitored in (such as throughput, energy consumption, new services deployment, SLA violations, and resource failures) Subsequently, it provides to the upper layer, i.e.

Executive layer, a determination of BLPs that are significant for BLOs decided by executives.

- *Executive Layer*: this layer captures variations in BDIM metrics (such as profit and clients’ satisfaction) caused by vacillations on BLPs relevant to each considered business objective.

BDIM has been studied extensively in the literature from different angles. The term Business-Driven IT Management was first used in [5] where a vision for an adaptive IT infrastructure was discussed. Alternative terms include: “Business-Oriented Management” [6], [7]; “Business Impact Management” [8], [9]; “Business Service Management” [10], “Service Impact Management” [11], “Business-Centric Service Level Management” [12], “IT Management driven by Business Objectives” – MBO [13]; recent IBM literature also refers to “Business Objectives” [14]. Although BDIM support tools are being introduced in the market [11], they are still in their infancy and functionally limited. On the other hand, BDIM has a revolutionary impact in future businesses.

Other research work discussed different deployment and policy issues of BDIM and factors associated with such deployments [15]-[19]. Our literature review map categorizing research efforts related to ours leading an evident research gap is depicted in Fig. 3. The research question to be addressed in this paper is: **Considering the organizations that apply BDIM, can cloud computing enhance the linkage between the IT metrics and Business metrics and how can that be achieved successfully?**

### III. RESEARCH FRAMEWORK AND DATA COLLECTION

#### A. Sampling and Participants Selection

This research targets the large enterprises’ business directors’ society in the UAE. According to the UAE chamber of commerce 2014 report, the number of the large businesses’ active licenses existed in UAE is 2,421, based on that we assume that the targeted population is approximately 5000 contributors. More than 100 responses were collected through different media i.e. Survey monkey® and linked-in®. The questionnaire participants are selected through the most popular social networking sites for business professionals such as LinkedIn® and Biznik®. Our selection criteria consider the following: the participant must have a relative business background and experience in the UAE; therefore, we reviewed the participant profile to ensure that she or he meets our criteria. The selected applicants were communicated and based on her/his approval of participation, an online survey link was sent in addition to a consent form that describes the purpose of research, the contact details, and the privacy policy. The targeted population of this work is the business heads or the directors in the large organizations in UAE. We focused our attention on the large establishments in the UAE such as holding groups and banks as they have the organization structure, resources, capabilities, manpower, and the infrastructure to implement BDIM model and cloud computing as well. Therefore, they represent the ideal environment to perform our researches and to test our hypotheses.

Data collection was achieved through developing and

distributing a questionnaire to a number of employees in different designations mainly in business fields (e.g. senior managers, managers, analysts, entry levels and others related IT staff), but the focus in the research was on the business senior managers, because they are the individuals in the organization most aware of the business metrics and can measure the impact of cloud computing on it, especially for our theoretical framework attributes i.e. productivity, quality of service, and organization cost.

#### B. Proposed Research Framework

Our proposed BDIM framework is based on different layers, which are:

- 1) The IT service layer that contains the IT services metrics.
- 2) The business processes layer that contains the business process metrics.
- 3) The business layer that contains the business metrics (e.g.: Revenue, profit, costs, financial loss, earnings-per share, production level, inventory turnaround, time from order to fulfillment, time-to-market, market share, frequency of new product launches, frequency of delayed, deliveries, average time for collection, age of accounts, receivables, ... etc.).

This can be illustrated as depicted in Fig. 4. by showing the relationship between these three layers:

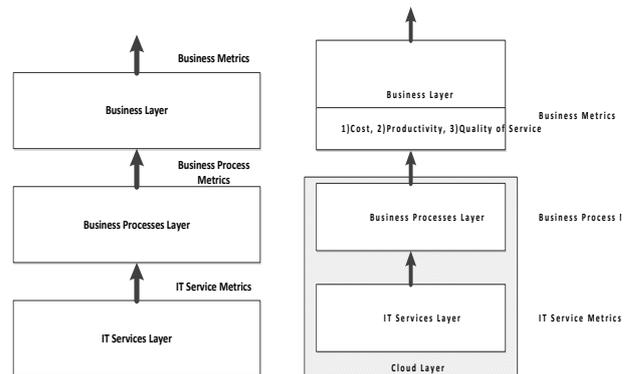


Fig. 4. Relationship between BDIM framework layers and suggested BDIM framework layers.

In our study, as we are interested in studying the impacts of having the cloud technologies adopted in the IT layer, and as we see that the cloud layer might be the host for the IT layer and the business processes layer, and as we focused in our study on six business metrics in the business layer, we suggest the following modifications to the framework layers as following:

- 1) The Cloud Layer, which is a container layer that would include the two following sub layers:
  - a) The IT layer, since by applying cloud computing, the IT services would be hosted on the cloud platform.
  - b) The Business processes layer, considering that by applying cloud computing, the majority of the related business processes will be shifted toward being hosted on cloud enabled platforms and hosts.
- 2) The Business Layer, which contains the business metrics. We focused on studying three metrics out of the many listed in the original framework, those are: cost, quality of

service, and productivity.

We used a semi-structured online questionnaire consisting of 28 single-sentence statements and asked the respondents to record their strength of agreement with each, on a scale from '1' (strongly disagree) to '5' (strongly agree). Most of the questions were multiple choice, in-addition to structured questions. The questionnaire was created based on the attributes of the theoretical research framework. A variety of questions' types have been used such as demographic, knowledge, and sensory questions. The purpose of the survey is to examine the impact of some factors on others such as the impact of decision making authority on the BDIM decisions, the impact of the cloud computing services on the organizations' traditional IT infrastructure and business processes, and finally the impact of the cloud computing on organizational flexibility.

IV. RESEARCH RESULTS AND ANALYSIS

Since the population of managers is larger than 500, statistical inference is used to test the hypotheses. A number of inferential methods are applied such as z-test, t-test, and one-sample and two-samples proportion tests. A binomial statistical test with a 5% significance level is used.

A. Demographic Analysis and Descriptive Statistics

The demographic questions in this research have been built to make sure that all related information technology practitioners have participated in this questionnaire, the combination of age, highest level of education, industry, decision-making authority, job title, total number of employees, experience and the type of the business sector. The relationships between the factors were more convenient, and reflected the impact of each one on the other factors as follows:

**The Relation between Decision Making Authority and the Job Title:** The relationship between the job title and the decision making authority is diverse, so some senior management positions have final decision-making authority and significant decision-making or influence, and some other managers have significant decision-making and minimal decision-making, other analysts have final decision-making authority, significant decision-making and minimal decision-making as shown in Table I.

TABLE I: RELATIONSHIP BETWEEN JOB TITLE AND DECISION MAKING

Answer Options	Private sector	Public sector	Voluntary sector	Response Percent	Response Count
Senior Manager	6	7	0	10.5%	13
Manager	0	11	12	21.1%	23
Analyst / Associate	6	28	13	47.4%	47
Entry Level	0	0	5	5.3%	5
Other	0	6	10	15.8%	15
<i>Total Answered</i>					<b>103</b>

**The Relationship between Organizational Sector and the Level of Decision Making Authority:** The analysis shows that most of the senior managers who have been selected for this questionnaire work for private and public sectors, however managers mostly work at private sectors and analysts equally

work in the both sectors as shown in Table II. We also summarize the use of cloud computing for critical data and the percentage use of BDIM applications in our sample data are shown in Fig. 5.

TABLE II: RELATIONSHIP BETWEEN AGE AND LEVEL OF DECISION MAKING

Answer Options	Private sector	Public sector	Voluntary sector	Response Percent	Response Count
Senior Manager	5	7	0	10.5%	12
Manager	15	7	0	21.1%	22
Analyst / Associate	27	21	0	47.4%	48
Entry Level	5	0	0	5.3%	5
Other	16	0	0	15.8%	16
<i>Total Answered</i>					<b>103</b>

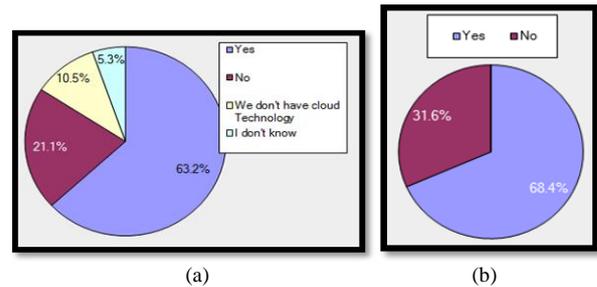


Fig. 5. (a) Cloud computing use for critical data (finance, contracts,...) (b) BDIM applications in companies.

B. Hypotheses Testing

Our first three hypotheses look at the role of cloud computing implementations on the business layer metrics including cost efficiency, productivity and quality of service (QoS).

- H<sub>1</sub>: Cloud computing implementations don't play an enhancement role in managing organization's cost efficiency, the following results were generated.
- H<sub>2</sub>: Cloud computing implementations don't play an enhancement role in managing organization's productivity.
- H<sub>3</sub>: Cloud computing implementations don't play an enhancement role in managing organization's quality of service.

The following results were generated as shown in Table III.

TABLE III: STATISTICAL SIGNIFICANCE RESULTS FOR H<sub>1</sub>, H<sub>2</sub> AND H<sub>3</sub>

Hypothesis	Agree	Disagree	N/D	Sig.
H <sub>1</sub>	90	11	2	<b>0.00006</b>
H <sub>2</sub>	81	18	4	<b>0.02783</b>
H <sub>3</sub>	71	11	18	<b>0.34144</b>

Accordingly, at a 95% confidence level, we have sufficient evidence to say most businesses decisions makers agree that cloud computing implementation play an enhancement role in managing organization's cost efficiency and productivity while we don't have conclusive results regarding cloud computing implementations role on QoS.

Our next two hypotheses focus more on the business directors' perspective of cloud computing in relation to either cloud computing or BDIM's successful implementation.

- $H_4$ : There is no relation between the successful implementation of BDIM in the organization and the business directors' perspective of cloud computing.
- $H_5$ : There is no relation between the successful implementation of cloud computing in the organization and the business directors' perspective of cloud computing.

To test  $H_4$ , the following  $2 \times 2$  contingency table (Table IV) was generated and analyzed.

TABLE IV: BDIM AND BUSINESS DIRECTORS PERSPECTIVE

	Agree	Disagree	Total
Cloud Computing	70	1	71
Lack of Cloud	22	10	32
Total	92	11	103

At a 95% confidence level, we applied a Chi-Square Test to compute a significance of  $5.68201E-06$  which is significantly less than  $\alpha=0.05$  and therefore we would reject  $H_0$  leading to the following conclusion: There is sufficient evidence to say that there is a relation between the implementation of BDIM in the organization and the business directors' perspective of cloud computing. To test  $H_5$  and examine if the business directors' decision or perspective regarding the effectiveness of cloud computing in the business is influenced with the using of cloud computing or not, Table V was generated and analyzed.

TABLE V: CLOUD COMPUTING AND BUSINESS DIRECTORS PERSPECTIVE

	Agree	Disagree	Total
Cloud Computing	84	3	87
Lack of Cloud	9	2	11
Total	93	5	98

Again, at a 95% confidence level, we applied a Chi-Square Test to compute a significance of  $0.036400598$  which is significantly less than  $\alpha=0.05$  and therefore we would reject  $H_0$  leading to the following conclusion: There is sufficient evidence to say that there is a relation between a successful implementation of cloud computing in the organization and the business directors' perspective of cloud computing.

## V. CONCLUSIONS AND FUTURE DIRECTIONS

Cloud computing has played a major role in many businesses resulting in advanced use of cloud applications to achieve business goals. This research paper analyses the effects of cloud computing on business metrics; such as cost, productivity and quality of service. A proposed BDIM framework was studied where the cloud layer acts a host to the IT layer and the business processes layer. We have found that most of the businesses decisions makers agree that cloud computing implementation plays an enhancement role in managing organization's cost efficiency and productivity. Moreover, there was a significant relation between the implementation of BDIM or cloud computing in the organization and the business directors' perspective of cloud computing.

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