

## BUSINESS INTELLIGENCE IN CLOUD

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**Abstract.** The paper reviews and critiques current research on Business Intelligence (BI) in cloud. This review highlights that organizations face various challenges using BI cloud. The research objectives for this study are a conceptualization of the BI cloud issue, as well as an investigation of some benefits and risks from BI cloud. The study was based mainly on a critical analysis of literature and some reports on BI cloud using. The results of this research can be used by IT and business leaders as they plan and develop BI cloud in their organizations.

**Key words:** business intelligence, cloud computing, business intelligence cloud

### Introduction

Recently many scholars and practices consider that cloud computing is a new technology to have the potential to transform a large part of the IT industry (Armbrust et al., 2010; Darrow, 2012). Cloud computing presents a model that provides on demand access to software and hardware resources with minimal management efforts. It gives users the facility to access computing power to which they might not otherwise have access due to financial or organizational limitations (Daugherty and Raj, 2008; Deshpande and Joshi, 2014; Tamer et al., 2013).

While various sectors already use this new technology successfully, the integration in more demanding areas such as Business Intelligence (BI) still holds many challenges. According to some authors cloud computing is not suited for all organization, especially in the field of BI (Cloud Security Alliance, 2010; Gurjar and Rathore, 2013; Hayes, 2008, Ouf and Nasr, 2011; Thomason and van der Walt, 2010).

Although, the idea of cloud computing has been explored for several years, unfortunately the investigations on BI cloud are only partly addressed by any existing research. The studies are rather rare, fragmentary and do not describe in a comprehensive way the benefits as well as risks offered by BI cloud. This paper seeks to throw more light on the concept of BI cloud.

The research objectives for this study are: (1) a conceptualization the of the BI cloud issue, (2) an investigation of some benefits and risks from BI cloud. In order to address these objectives, the remainder of the paper is structured as follows: The first section provides the theoretical foundations of BI and cloud computing theory. Next, the BI cloud was conceptualized. Finally, some benefits and risks of BI cloud were explored. The study was based mainly on: (1) a critical analysis of literature, and (2) some reports of BI cloud using. The results of this research can be used by IT and business leaders as they plan and develop BI cloud in their organizations.

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### **Background on Business Intelligence and cloud computing**

BI has become the significant research area in the domain of management information systems in the last years (Chen and Chiang, 2012). The roots of BI originate from decision support systems, which first emerged in the early 1970s when managers used computer applications to model business decisions (Moss and Atre, 2003; Negash and Gray, 2008; Wixom and Watson, 2010). Over the years, other applications, such as executive information systems, online analytical processing (OLAP), data warehousing, and data mining became important (Chen and Chiang, 2012; Davenport et al., 2010). Today BI is compared to "an umbrella" that is commonly used to describe the technologies, applications, and processes for gathering, storing, accessing and analysing data to help users to make better decisions (Davenport et al., 2010). BI is comprised of both technical and organizational elements. From technical point of view BI is an integrated set of tools, technologies and software products that are used to collect heterogenic data from dispersed sources and then to integrate and analyse data to make them commonly available. The key BI technologies include: data warehousing, data mining and OLAP (Olszak, 2013).

From organizational perspective, BI means a holistic and sophisticated approach to cross-organizational decision support. BI is responsible for transcription of data into information and knowledge (Moss and Atre, 2003; Negash and Gray, 2008). Also, it creates some environment for effective decision-making, business processes, strategic thinking, acting in organizations and taking the competitive advantage.

It is highlighted that over time, BI systems have evolved into integrated and highly complex BI architectures (Al-Shubiri, 2012; Moss and Atre, 2003). This fact results that the costs of implementation of such BI architectures are very high and unattractive for many organizations (Gurjar and Rathore, 2013).

Last time many researches confirm that organizations are facing the following challenges when making use of BI (LaValle, 2009; Thomason and van der Walt, 2010):

- a pressing need exists for companies to reduce capital expenditure and operational cost;
- there is a shortage of skills to effectively create and maintain a business analytics solution that adds value to the business;
- the business of today generate large volumes of data from all different data resources, including enterprise resource planning (ERP) systems, customer relationship management (CRM) solutions, Global Positioning systems (GPS) logs and tweets;
- the velocity with which data is generated is enormous and arrives on a daily, hourly and real-time basis. This requires powerful machines to process the data to identify trends in that data and can sometimes only be executed in the evening not to effect the business during working hours;

- the business requires an on-demand solution for sales analysis, supply chain visibility, customer analytics, merchandising and product analysis;
- in order to control infrastructure costs can be an enormous task to ensure that the appropriate infrastructure is available for peak times;
- the costs for implementing and maintain a business analytics solutions is expensive.

Additionally, it should be pointed that BI is expensive to implement and maintain for many organizations and also requires powerful infrastructure which is sometimes only available after hours. The last recession brought a pressing need for business to reduce cost but still have the right technology in place to allow them to make decisions that allows them to identify opportunities and proactively identify risks that can affect the business. This is where cloud computing can offer business a solution to reduce costs but still have access to best of breed solutions (Thomson and van der Walt, 2010).

Cloud computing has no universal accepted definition. Cloud is often just seen as infinite computing resources available on demand (Armbrust et al., 2010). The National Institute of Standards and Technology defines cloud computing as a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or services provider interaction (Peter and Timothy, 2011). Cloud computing presents a model that provides on demand access to software and hardware resources with minimal management efforts. Gartner defines cloud computing as a style of computing where massively scalable IT-enabled capabilities are delivered as a service to external customers using Internet technologies (Gartner, 2013). Cloud computing is a virtual environment which gives users the facility to access computing power to which they might not otherwise have access due to financial or organizational limitations (Tamer et al., 2013). It shares its resources among a cloud of service consumers, partners, and vendors. By sharing resources at various levels, this platform offers various services, such as an infrastructure cloud, a software cloud, an application cloud and a business cloud (Cloud Security Alliance, 2010).

In order to better understand the concept of cloud computing, main features of cloud computing are presented. They concern (ISACA, 2009; Li et al, 2010; Malcolm, 2009; Tamer et al., 2013):

- virtual, dynamic, scalable and massive infrastructure;
- shared, configurable, flexible, dynamic resources;
- accessible via Internet from any device;
- platform with minimal management or self-management;
- utilization model based on self-service.

It is worth mentioning that cloud computing consists of different layers. They include first of all (Daugherty and Raj, 2008):

- industry clouds – externally provisioned service for managing a business process that is Internet-enabled. Examples of these services include claims

processing, expense management or procurement and the processes are typically priced on a per-transaction basis exist;

- application cloud (desktop, and collaboration, SaaS). This layer provides services from procurement to ERP systems and content management systems;
- platform cloud – it allows software vendors to develop and deploy online applications quickly;
- infrastructure cloud or utility computing – cloud computing vendor provides raw infrastructure, such processing power, network bandwidth, storage and memory to companies on an on-demand basis.

There are also more sophisticated approaches to cloud which constitute cloud computing as a new paradigm in IT sourcing that increases agility and enables new business models (Hayes, 2008). It is said that cloud computing results in the on-line life quality, the development of an economy and innovation. The cloud overcomes the cross-border barriers. It generates the profits for all users of the cloud. Cloud-base services are available at all levels of the enterprise technology stack. Business is free to evolve individual IT models, based strictly on business needed rather than on technology constraints. This new, adaptable IT framework could simplify managing cost, scale and agility. Cloud computing can create a new wave of innovations in the cloud and an increased computing industrialization of IT. These innovations may result in changes in business models and allow new levels of benefit for companies tapping into its power. A recent study (Avanade, 2009) shows that 71% of the organizations consider cloud computing a realistic technological option, 70% believe that it would lead to increased business flexibility, 62% consider that it would speed up response to market conditions, and 65% consider that it would lead to increased focus on the main aspects of the business.

One of the biggest issues facing cloud computing is data security. Cloud users face security threats both from outside and inside the cloud. Many of the security issues involved in protecting clouds from outside threats are similar to those already facing large data centers. In the cloud, however, this responsibility is divided among potentially many parties, including the cloud users, the cloud vendor, and any third-party vendors that users rely on it for security-sensitive software or configurations (Tamer et al., 2013).

### **Conceptualization of cloud Business Intelligence**

Most of decisions support systems reside on-promises. However, due to the increasingly digital presence of data many BI vendors are offering tools on the cloud (Sabherwal and Becerra-Fernandez, 2011). BI solutions based on cloud computing are called “*cloud BI*” or “*BI services on demand*”. Cloud computing has made BI tools more accessible. Organizations do not need to implement and support the large volumes of data as well as massive processing power. Cloud BI presents a model that provides on demand access to software and hardware

resources with minimal management efforts (Tamer et al., 2013). Cloud BI is the new way to do BI. It is said that cloud BI is a revolutionary concept of delivering business intelligence capabilities “as service” using cloud based architecture that comes at a lower cost yet faster deployment and flexibility (Gurjar and Rathore, 2013). It is accessible via any web browser in a so-called software –as-a-service model. It is reported that cloud computing transforms the economics of BI and pens up the opportunity for smaller enterprises to compete using the insights that BI provides (Ouf and Nasr, 2011). Cloud BI solution has special interest for organizations that desire to improve agility while at the same time reducing IT costs and exploiting the benefits of cloud computing (Gurjar and Rathore, 2013). Typically, a cloud BI platform is used to solve one of the three primary customer needs (Ouf and Nasr, 2011):

- as a horizontal BI tool to deliver standalone, internally facing reporting and analysis applications – probably using a traditional relational database (or data mart) as the primary source data system;
- as an application framework or pre-built reporting and analysis template for systems integrators to use for assembling customer-specific solutions more quickly. These solutions are probably function or domain- specific and contain reusable components and application logic (but are assembled uniquely for each customer);
- as a development platform that enables embeddable, externally-facing applications that solve a function-specific data analysis problem (for example CRM analytics, financial analytics, or supply chain analytics).

There are many options, both from traditional BI vendors and from newcomers, providing different BI functionality based on different architectures and platforms (Table 1).

**Table 1. Architectures and platforms for cloud BI** (Menon and Rehani, 2014)

Architecture and platform	Representative vendors
SaaS BI Solutions	Adaptive Planning, Analytix On Demand, Birst, BlinkLogic, GoodData, HostAnalytics, Indicee, LiteBI, Oco, PivotLink BI, SAP Business Objects on Demand
BI/DW Platform as a Service (PaaS)	AsterData MPP on Amazon EC2, IBM Cognos Express on Amazon EC2, Teradata Express on Amazon EC2, RightScale/ Talend/Vertica/Jaspersoft on Amazon EC2
Traditional BI hosted	Actuate, IBM Cognos, Information Builders, Jaspersoft, Kognitio, MicroStrategy, Oracle, Panorama Software, Pentaho, QlikView, SAS Institute, TIBCO Spotfire
SaaS BI Packaged Analytic Application Solutions	Cloud9 Analytics, IBM Cognos Analytic Applications, PivotLink, Rosslyn Analytics, SAS, SAP BusinessObjects BI On-demand for Salesforce
Cloud Based Data Integration Tools	IBM Infosphere DataStage, IBM CastIron, Informatica Powercenter Cloud Edition, Snaplogic Dataflow, Talend Integration Suite on RightScale Managed Platform

In spite of the unquestionable advantages, BI in the cloud comes with number of risks and vulnerabilities. Most notably threat to security (Tamer et al., 2013). In the next section, I explore some most important benefits and risks of BI in cloud.

### **Benefits of Business Intelligence on the cloud**

The review of the literature suggests that cloud computing transforms the economics of BI and opens the opportunity for organizations to compete on the global market (Gurjar and Rathore, 2013). According to research (Dimensional Research, 2008), cloud BI solutions were viewed as beneficial with 78% saying they would see value. Several participants took the time to point out that the demand for data analysis in a BI solution is very uneven, which makes it a particularly good fit for a cloud solution. Participants of research indicted the various benefits from using cloud BI. They include among others: easier to access data stuck in application silos (54%), provide increased visibility of operational and financial data across the organization (46%), faster deployment than traditional on-premise BI (42%), easier for business stakeholders (36%), no benefits (22%), others (3%). Gartner survey throws the fact that almost one-third of the BI platform users surveyed are using or planning to use the cloud (Gartner, 2014; Wisdom of Crowds Cloud Business Intelligence, 2012).

The detailed review of the literature allows to state the benefits from cloud BI may have a technological, financial, and organizational nature.

The first group of benefits concerns:

- easier evolution of technology. Clouds enables software companies to make new technology available to evaluators on a self-service basis, avoiding the need to download and set up free downloads or acquire hardware's fitting to the technology (Gurjar and Rathore, 2013; Prashad, 2012; Tamer et al., 2013);
- increased elastic computing power. The cloud lets users avoid the necessity to upgrade the computing power of their on-premise systems in order to use BI. It allows BI users to call on increased computing power as needed (Darrow, 2012);
- accelerating BI technology adoption. The cloud becomes the default platform for evaluating new software (Ouf and Nasr, 2011).

The financial benefits refer first of all to:

- potential cost saving. The cloud allows companies to reduce their operational cost and make use of the solution on a subscription basis. This eliminates the need for going through long capital requests (Thomason and van der Walt, 2010). According to Garter research cost models can be cheaper over the first five years, as a direct consequence of adoption the cloud (Gartner, 2012). Long-terms cost reductions are more difficult to quantify, but include the potential for reduced personal costs and reduced IT support costs (Darrow, 2012);
- time saving. Clouds drastically reduces the BI implementation (Menon and Rehani, 2014; Ramesh, 2013);

- increased short-term ad-hoc analysis. The cloud makes short term projects very economical (Ouf and Nasr, 2011). Data mart may be created in a few hours or days (Deshpande and Joshi, 2014);
- easier and cheaper evaluation. The cloud enables software companies to make new technology available to evaluators on a self-services basis, avoiding the need to download and set up free software download (Ouf and Nasr, 2011).

The organizational benefits include mainly:

- easy deployment and increased flexibility and agility. The cloud makes it easier for company to adopt a BI solution and quickly experience the value. Deployment requires less complicated upgrades for existing processes and IT infrastructure (Gartner, 2012; Petty and Goasduff, 2012). Cloud computing allows for scaling up and down as capacity is required by the business and this is paid incrementally to the cloud computing vendor (Taths, 2013). The cloud enables isolated business units to respond to BI needs faster than their competitors and increase the quality of their strategy setting and execution (Deshpande and Joshi, 2014);
- supportive of nomadic computing. BI cloud allows employees and BI users to move from place to place without losing access to tools and information systems (Becerra-Fernandez et al, 2007);
- storage large amount of data. Cloud provides an appropriate infrastructure for storing large amount of data at low cost (Gurjar and Rathore, 2013);
- expertise support (Wisdom of Crowds Cloud Business Intelligence, 2012);
- focus on core strength. Outsourcing running of BI applications to professionals and focus on core capabilities (Gurjar and Rathore, 2013).

Despite the numerous benefits of adopting cloud BI, there are many risks and vulnerabilities. Cloud also raises significant challenges such as lack of cloud trust and security, insufficient availability, legal issues or the fear of vendor lock-in. Furthermore, in many cases the integration of cloud solution may not make sense for economic reasons or simply can't be realized due to technological limits.

### **Risks and vulnerabilities of Business Intelligence on the cloud**

Many scholars argue that cloud computing requires a transparency of data processing, rules and models and the security of intellectual capital. Unfortunately, many organizations, as well countries do not have an appropriate developed strategy in this area. Recently, UE has made some attempts to solve this problem. In September 2012, the European Commission adopted a strategy for "Unleashing the Potential of Cloud Computing in Europe". The strategy is designed to speed up and increase the use of cloud computing across all economic sectors. This strategy is the result of an analysis of the overall policy, regulatory and technology landscapes and of a wide consultation with stakeholders, to identify ways to maximize the potential offered by the cloud (About Cloud computing, 2014).

According to Tamer et al. (2013), Menon and Rehani (2014) there are also many inhibitors which have resulted in a very slow adoption rate to cloud BI so far. They concern mainly:

- data security. Security concerns including confidentiality, integrity and availability of the data to the cloud. For some organizations, the concerns over security may be a barrier that is impossible to overcome today. With cloud computing, data is stored and delivered across the Internet. As a result, there are many risks surrounding the loss or compromise of data. Data hosting may be untrusted or unsecure, with the potential for data leakage. However, in many cases, the cloud vendors provide a more secure environment than what exists at customer sites;
- on premise integration. Data integration capability, one of the core BI capabilities, is crucial to defining a successful and robust BI solution. The cloud presents the potential for compromised data, metadata, and application integration. However, sudden movement to cloud is not feasible and a phased approach is usually recommended. There will be a co-existence model until the cloud BI market is more mature;
- lack of control. Tough to get Service Level Agreements (SLAs) from cloud providers. Data control and data ownership, reliability of service challenges are some of the main reasons for client concern. To mitigate this, organizations should already have in place thorough IT governance and service delivery standards and models;
- vendor maturity. Too many cloud BI vendors, hosting providers with varying offerings, etc. makes it confusing to choose the right vendor based on required needs and vendor capabilities;
- performance. Limits to the size and performance of data warehouses in the cloud, significant latency if BI applications exist in the cloud but the data exists at a client site, especially when processing and returning large amounts of data;
- pricing models. Lack of standardized pricing models makes it difficult for customers to select the right one;
- some analytics consider that returns on investment in cloud-based BI solutions have not been fully proven nor yet measured.

### **Conclusion**

The main conclusion for this study is that cloud computing trends cannot be ignored in BI field. Cloud computing promises significant benefits. Cloud BI has been developed in order to enhance the efficiency and productivity of business intelligence and increase the performance of BI software. It helps in shorting BI implementations, reduction of cost BI applications. Cloud facilitates testing and upgrading of BI programs. Despite of these undoubted advantages, there are various risks and vulnerabilities during cloud BI using. Security, data protection, lack of control, and several other barriers prevent widespread adoption of the BI



cloud. It also seems that many factors (including the size of the organization, its nature, and its strategic objectives) have to be considered to reasonably assess the use of BI clouds.

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## BUSINESS INTELLIGENCE W CHMURZE

**Streszczenie:** W artykule dokonano krytycznego przeglądu i analizy literatury przedmiotu na temat Business Intelligence w chmurze (cloud computing). Zwrócono uwagę, że organizacje, które decydują się na przetwarzanie w chmurze stają przed różnymi

wyzwaniami i problemami. Celem opracowania jest konceptualizacja zagadnienia BI w chmurze, jak również zbadanie korzyści oraz niebezpieczeństw wynikających ze stosowania przetwarzania w chmurze. Badania przeprowadzono w oparciu o krytyczną analizę literatury przedmiotu oraz raporty firm analitycznych. Uzyskane wyniki badań mogą okazać się użyteczne dla specjalistów IT i menedżerów, planujących w swoich organizacjach rozwój przetwarzania w chmurze.

**Słowa kluczowe:** Business Intelligence, przetwarzanie w chmurze, chmura Business Intelligence

### 商務智能雲

**摘要：**本文介紹了在雲（雲計算）進行嚴格審查，並在商業智能的文獻分析。據指出，該選擇雲計算的組織都面臨著不同的挑戰和問題。這項研究的目的是BI在雲中的問題的概念化，以及檢查從使用雲計算所帶來的好處和危險。這項研究是基於文獻和報告分析公司的批判性分析。得到的結果可能是為IT專業人員和管理人員在他們的組織策劃，開發雲計算是有用的

**關鍵詞：**商業智能，雲計算，商業智能雲