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Cloud Business Intelligence

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ABSTRACT

Using Business Intelligence in the cloud is considered a key factor for success in various fields in 2018, about 66 percent of successful organizations in BI already using cloud. 86% of Cloud BI adopters choose Amazon AWS as their first choice, 82% choose Microsoft Azure, 66% choose Google Cloud, and 36% identify IBM Bluemix as their preferred provider of cloud BI services. In recent years, both Business Intelligence and cloud computing have undergone dramatic changes and advancements. The newest capabilities that these recent developments bring forth are introduced. In this paper the latest technologies in the field of Cloud (SaaS) BI is introduced. The paper shows also that many of the current problems in Cloud (SaaS) BI can be solved by enhance the performance and increase the use and acceptance of this technology. Many of the key characteristics of Business Intelligence systems tend to complement those of cloud computing systems and vice versa. Therefore, when integrated properly, these two technologies can be made to strengthen each other's advantages and eliminate each other's weaknesses.

Keywords - **Business Intelligence, Software as A Service, Infrastructure as A Service, Platform as A Service, Enterprise Information Integration, Cloud Computing.**

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I. INTRODUCTION

The Cloud Model requires leveraging the traditional on-premise enterprise architecture by enabling higher economies of scale. Having realized this need, many organizations (IT and non-IT) have already begun democratizing their globalized IT landscapes, to offer as services both internally and externally. This services that are ubiquitous in provisioning are termed as utility computing services as consumers pay in consonance with their utilization. This service has further resulted in burgeoning growth of ancillary service lines viz., SaaS, IaaS and PaaS[1].

In recent times business intelligence (BI) has been under mounting pressure to evolve as an all-pervasive information and analytics agent. The strengths of the cloud model viz., accelerated speed-to-market, reduced TCO, scalability, etc., has led many BI vendors to introduce cloud services as a clear and distinctive extensions to the on-premise and on-demand BI applications [Fig. 2].

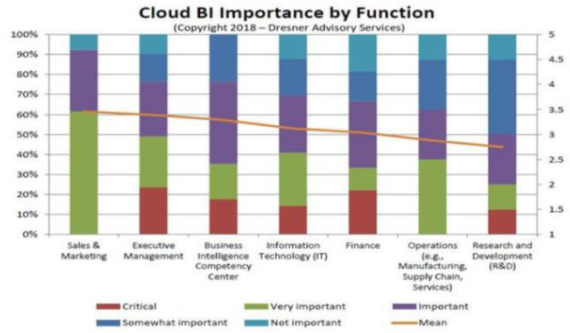

Fig. 1 Cloud BI Importance by Function [17]

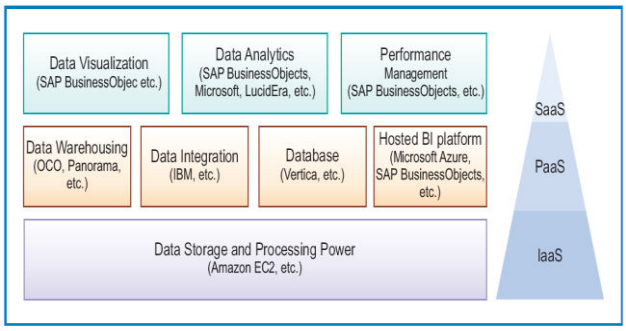

Fig. 2: BI in the cloud [1]

Many organizations are, thus, slowly complementing the decentralized architecture with a SOA enabled federated data warehouse solution, to satisfy the increase in demand for collaborative and globalized decision making. This movement, towards Enterprise Information Integration (EII), has been further accentuated by the emergence of the cloud. Gartner, in a recent research, reported that many organizations are increasingly adopting cloud-based application services even in midst of fears over loss of data control, security and privacy [2].

In the current business environment, tightening regulations with economic uncertainties have further added to the need for business agility. Gartner reports that given the perceived complexity of BI, just about 15-20% of business users use BI [Fig. 3]. The same report says that emerging technologies will make it easier to build and consume analytical applications thus marginalizing the role of IT in BI [3].

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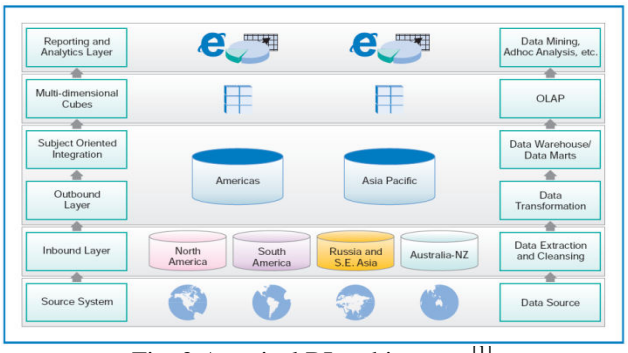

Fig. 3 A typical BI architecture [1]

Table 1: Cloud Challenges and Mitigation Strategy.

Challenges in the Cloud Model	Mitigation Strategy
Data Migration	Less sensitive data and business processes involving users from both inside and outside the organization (e.g., vendor management, sales and campaign management, etc.) would be best suited for the cloud.
Data Integration	As some of the BI capabilities are moved on to a cloud some of the prospective technologies would be different from the on-premise stack. In such a case, data governance around metadata management and unification would be of utmost importance.
Data Security	Before tapping into the cloud for enhancing the company's analytics potential, the BI architects must put in place processes for data encryption, role based authorizations, etc., to ensure security of company sensitive data.
Performance Optimization	With the simplification of architecture through usage of parallel processing, thus, ensuring optimization around data volume management, cloud offerings will enhance user experience with quick response times and seamless rendering of data. In order to ensure this, a proper utilization model would have to be designed to allocate timelines and resource limits (upper and lower) to the participant entities.

The data staging or inbound layer forms the most granular stratum of the data model. This layer that also houses the extraction programs is the most frequently impacted one despite efficient loading schedules. Thus, it requires the maximum amount of housekeeping by the system administrators. This layer is the most susceptible one to come under the BI architect's radar to transform onto a cloud service. By pooling resources from various geographies/business units, enterprise architects can form a private cloud by centralizing the computing power and capacity while virtually partitioning the allocation of these resources. The BI architect can then host the staging layer on the cloud by initiating an appropriate data governance model at the data source layer itself and utilize the extraction logic to cleanse and profile the data. [Fig. 4]

Another layer from the BI value chain that is most likely to be hosted on a cloud is reporting and analytics [Fig. 5] decision making in multi-national organizations is evolving towards a collaborative model with diverse business users performing data mining, intuitive search, etc., on enterprise-wide data to make decisions of global effect. BI architects can create a cloud using internal resources to have reports from various business streams. They can also host these reports using a public cloud for seamless access by their mobile workforce, provided an appropriate data governance model is introduced at this level as well.

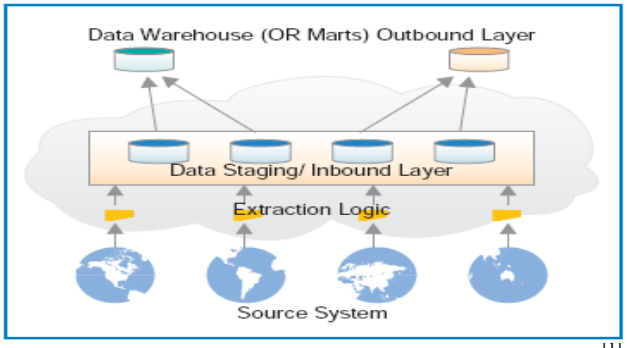

Fig. 4 Data Staging on a Cloud – A Federated Approach [1]

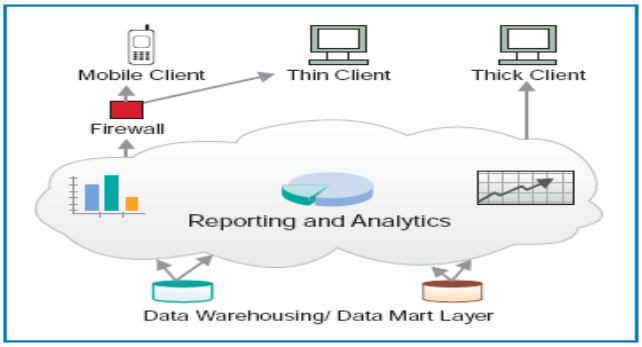

Fig. 5 Reporting and Analytics on a Cloud – Enabling Self-Service [1]

II. BUSINESS INTELLIGENCE INFRASTRUCTURES

In order to fathom the potential of Cloud BI, the structure and characteristics of the affected infrastructures need to be considered. The foundation of the following discussion is the three-layer architecture [4] [Fig. 6]. In the following, the layers are discussed in further detail.

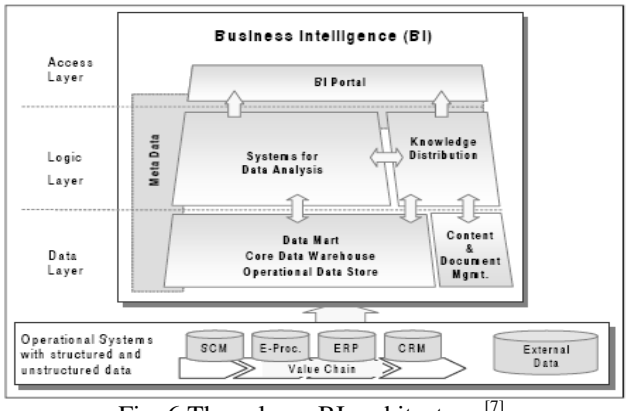

Fig. 6 Three-layer BI architecture [7]

A. *The Data Layer*

The Data Layer is responsible for storing structured and unstructured data for management support. Regarding structured data, the central component is the DWH. A DWH is commonly defined as a "subject-oriented, integrated, time-variant, and non-volatile collection of data in support of management's decision-making process" [5]. Many current realizations of DWHs

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are based on so called Core DWHs that are designed for an application independent storage of management support data. Core DWHs are usually not used as a direct source for analysis systems, but rather distribute data to individual Data Marts. Data Marts keep excerpts of application specific data.

B. The Logic Layer

The Logic Layer provides functionality to analyze structured data or unstructured content and supports the distribution of relevant knowledge among different users. The most salient tools in BI environments are reporting, data mining, and OLAP tools [6]: Reporting tools present quantitative data in a report-oriented format that might include numbers, charts, or business graphics. OLAP denotes a concept for interactive and multidimensional analysis of aggregated quantitative business facts. Data mining tools support the identification of hidden patterns in large volumes of structured data based on statistical methods like association analysis, classification, or clustering [7]. Data mining and similar model-based tools are also referred to by the term Advanced Analytics [8].

C. The Access Layer

The Access Layer allows the user to conveniently use all relevant functions of the Logic Layer in an integrated fashion – within the confines of defined user roles and user rights. Usually the Access Layer is realized with some sort of Portal software that also provides a consistent web-based user interface. The proliferation of standards like JSR 2003
and JSR 2008 allows a flexible integration of BI analysis components. Portal software meets many criteria that can foster a SaaS (and therefore Cloud) approach – it relies on standards, is relatively unspecific and usually uncritical.

III. BUSINESS INTELLIGENCE SERVICES

By adding two dimensions, BI services can be delineated more specifically – and be later combined to BI solutions with a defined distribution of responsibilities. The resulting "BI service grid" and its three dimensions (component, business specificity, life cycle) are visualized in [Fig. 7]. It has been developed for the management of BI sourcing and BI governance approaches [9; 10].

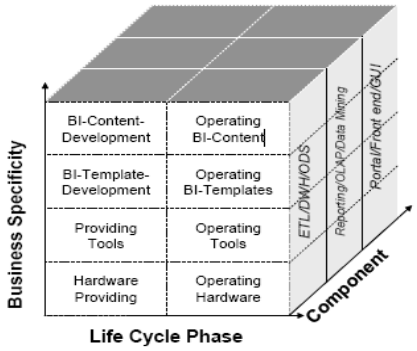

Fig. 7 BI service grid [10]

The starting points for the BI service grid are the software components in the BI infrastructure, e.g. based on the three-layer architecture introduced above. The components can also be adapted to individual needs or be further broken down if necessary.

The second-dimension *business specificity* builds up on the concept of the "service stack" [11] and distinguishes between infrastructural services, like database hardware provision or BI tool hosting, and services closer to business, e.g. indicator definition or the development of a report.

The core criterion for differentiating along this dimension is the allocation of responsibilities between the provider and the user of BI services. The more responsibility for the business content is shifted to the provider, the more (s)he needs comprehension of specific business semantics and user context.

The grid proposes the distinction of four layers:

A. Hardware – provision and running of the relevant computing, storage, and network equipment necessary to operate one or more BI components. In the web-based context of Cloud Computing, handing out this layer corresponds to an IaaS approach. Here, virtualization brings flexibility regarding both the physical location and assigned resources like CPU power or storage – highly relevant arguments when considering the volatility of resource consumption in BI. Hardware abstraction is especially interesting for facilitating scalability and portability and it might give medium sized enterprises access to hardware power that was otherwise be out of reach for them (e.g. because they cannot afford "DWH appliances" [12]). There is a catch: As discussed above, high-end requirements on the DWH side (latencies, data volume) are often at odds with an Internet based provision model. It can therefore be doubted that virtualization relieves of the cumbersome installation, tuning, and operation tasks for truly demanding ODS/DWH installations.

B. Software tools – this relates to the BI software, from ETL tools to data visualization packages. For Cloud Computing, services on this level incur a SaaS approach. As discussed above, the resolution of the portfolio of managed components needs to be adjusted to individual needs. The software units in discussion can range from complete applications down to atomic functional blocks that are delivered as web services. A facilitator for applying Cloud concepts on tool level is the fact that most state-of-the art BI software products now come with rich web interfaces that match or even surpass the former stand-alone clients. However, with respect to the distribution aspect of Cloud Computing, it needs to be acknowledged that many BI tools on the data and analysis layers still lack multi-tenancy capabilities, let alone mechanisms for handling multiple instances or for load balancing. This doesn't inhibit a Cloud approach (as it can be circumvented with hardware virtualization) but it surely makes its application more difficult.

C. Templates – understood as preconfigured applications and prearranged contents that can be adapted

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to individual needs. Several larger BI suites deliver ready-to-use templates and include features to build own ones. Templates have become a powerful tool in BI to reduce development cycle time, foster reuse, and impose rules regarding application development on the user side. However, they are still tightly bound to the BI software tool products. An uncoupling of the layers is therefore currently not of much relevance for Cloud BI.

D. Content – this pertains to the actual business semantics. A provider who operates on this layer takes over responsibilities for the definition, gathering, structuring, transformation, and/or presentation of data. As Cloud Computing is here understood to be a means for outsourcing hard and software, the content layer is excluded from the further discussion. The third dimension that can be addressed refers to the *application life cycle*: It an be differentiated whether a service is devoted to the development of components or on their operation. This dimension becomes relevant in Cloud Computing when components allow or even foster a web-based development, e.g. by making use of PaaS and technologies like mashups.

IV. CLOUD BI AND INDUSTRY

66 percent of successful organizations in BI already using cloud. 86% of Cloud BI adopters chose Amazon AWS as their first choice, 82% chose Microsoft Azure, 66% chose Google Cloud, and 36% identify IBM Bluemix as their preferred provider of cloud BI services. The least likely current or future users are found in manufacturing and security-sensitive healthcare organizations, where 45% respondents report no plans for cloud-based BI/analytics.

Sales & Marketing need real-time feedback on key initiatives, programs, strategies, and progress towards goals. Dashboards and advanced visualization features' dominance of feature requirements reflect this department's ongoing need for real-time feedback on the progress of their teams towards goals. Reporting, data discovery, and end-user data blending (data preparation) make up the next tier of importance Fig [8,9].

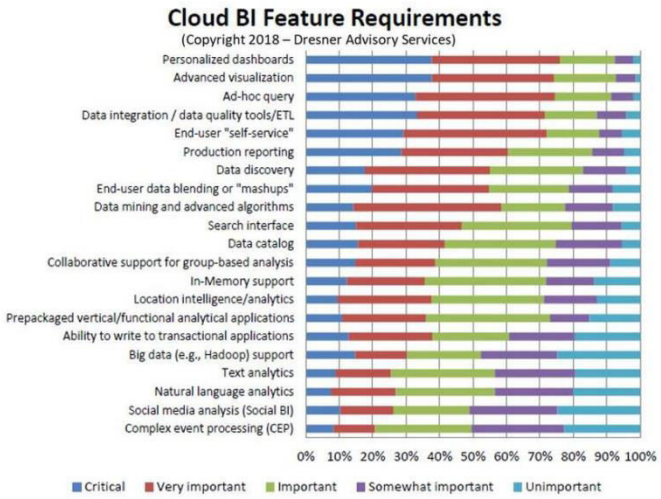

Fig. 8: Cloud BI Feature Requirements [17]

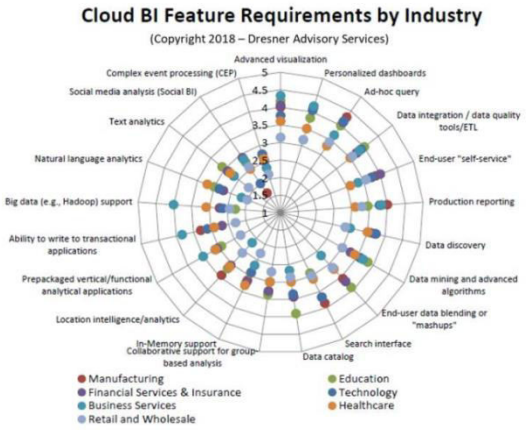

Fig. 9: Cloud BI Feature Requirements by Industry [17]

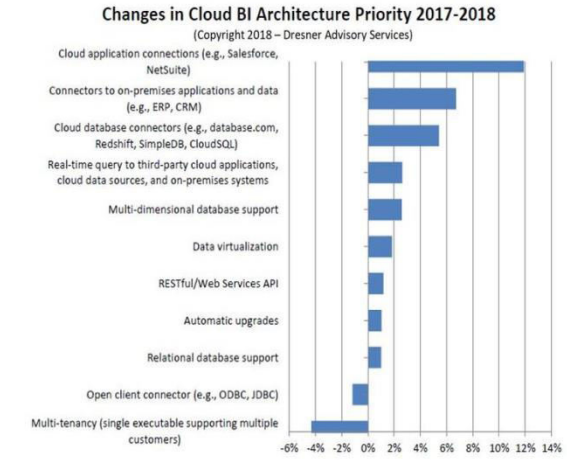

Fig. 10: Changes in Cloud BI Architecture Priority [17]

V. THE BENEFITS OF CLOUD COMPUTING FOR BUSINESS INTELLIGENCE

Utilizing SaaS solutions are an effective way to minimize costs and maximize performance. But there are many noteworthy benefits of Clouding BI and using a BI reporting and analytics tool as a SaaS application [13]:

A. Fast, easy and inexpensive deployment: Lack of infrastructure set up means a faster Return on Investment (ROI).
B. No hardware and setup expenditure: Reduced implementation costs equate to a low Total Cost of Ownership (TCO).
C. Reliability: Cloud Computing that uses multiple redundant sites can provide reliable and secure locations for data storage and are ideal for disaster recovery and business continuity
D. No capital expenditure (lowers entry barriers): No capital expenditure normally associated with setting-up traditional IT environments means the benefits of BI can be rolled out faster to more people within your organization. [14]
E. Multi-tenancy environment (do more with less): The multi-tenancy nature of Cloud Computing means that cost and resources can be spread across many users

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F. Free automated software upgrades and maintenance: The service provider owns and hosts the software, and so users can benefit from ongoing upgrades and maintenance without the associated costs, time constraints and drain on IT resources

G. Flexibility and scalability associated with low ongoing total software costs: Freedom from upgrade and maintenance expenses mean that it's easy to keep fiscal control over IT projects and have the flexibility to scale up or down usage as needs change

H. Only pay for what you use: SaaS ensures that users only pay for what they use, eliminating wastage, resulting in low ongoing software costs.

I. Fast and easy scalability: Cloud solutions can support large numbers of simultaneous users, meaning that customers can swiftly increase their software usage without the cost or delay of having to deploy and install additional hardware.

J. Flexibility: Cloud BI solutions have the flexibility to be altered quickly to give technical users access to new data analysis and reporting features

K. Improved data sharing capabilities: Cloud applications enable easy cross-location data sharing and remote data access as they are deployed via the internet and outside a company's firewall. [15]

L. Low risk and high reward: Low TCO and overall resource investment means that SaaS represents a low risk venture that retains high reward potential.

VI. CONCLUSION

Cloud BI adoption is soaring in 2018, nearly doubling 2016 adoption levels. Cloud BI influences the way business intelligence software projects are managed which it provides a virtually unlimited pool of computing power, storage space and memory for the business intelligence infrastructure [16].

Dashboards, advanced visualization, ad-hoc query, data integration, and self-service are the most-required Cloud BI features in 2018. Manufacturers have the greatest interest in dashboards, ad-hoc query, production reporting, search interface, location intelligence, and ability to write to transactional applications. As shown in Figure 10, it is expected to see this accelerate in 2019 as Cloud BI apps become more pervasive across Marketing & Sales and Executive Management, in addition to Operations including supply chain management and manufacturing where real-time shop floor monitoring is growing rapidly [17].

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