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ORIGINAL

Analyzing the Influence of Cloud Business Intelligence on Small and Medium Enterprises A Case Study of Morocco

Análisis de la influencia de la inteligencia empresarial en nube en las pequeñas y medianas empresas Un estudio de caso de Marruecos

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ABSTRACT

Business intelligence (BI) has long been a crucial factor in bolstering organizational competitiveness, offering strategic insights that shape decision-making and propel business expansion. The advent of cloud computing has further amplified data sharing and collaboration. This study advocates for the adoption of Cloud BI as an innovative tool to bolster the economic growth of small- and medium-sized enterprises (SMEs) in Morocco. We emphasize the interconnectedness of these businesses' performance with the overall well-being of the Moroccan economy, underscoring the need for regulatory bodies to prioritize not only financial support but also a keen focus on technological advancements. We explore how technological integration can enhance the competitive edge of SMEs. Finally, we conclude by presenting a framework that incorporates the migration of BI to the cloud within the realm of Cloud BI. Drawing inspiration from prior research, we propose modifications tailored to address the specific concerns of SMEs in embracing cloud BI technology.

Keywords: Business Intelligence; Cloud Computing; SMEs; Morocco; Homomorphic Encryption.

RESUMEN

La inteligencia empresarial (IE) ha sido durante mucho tiempo un factor crucial para reforzar la competitividad de las organizaciones, ya que ofrece información estratégica que determina la toma de decisiones e impulsa la expansión del negocio. La llegada de la computación en nube ha ampliado aún más el intercambio de datos y la colaboración. Este estudio aboga por la adopción del BI en la nube como herramienta innovadora para impulsar el crecimiento económico de las pequeñas y medianas empresas (PYME) de Marruecos. Hacemos hincapié en la interconexión del rendimiento de estas empresas con el bienestar general de la economía marroquí, subrayando la necesidad de que los organismos reguladores den prioridad no sólo al apoyo financiero, sino también a los avances tecnológicos. Exploramos cómo la integración tecnológica puede mejorar la ventaja competitiva de las PYME. Por último, concluimos presentando un marco que incorpora la migración del IE a la nube dentro del ámbito del Cloud BI. Inspirándonos en investigaciones anteriores, proponemos modificaciones adaptadas para abordar las preocupaciones específicas de las PYME a la hora de adoptar la tecnología de IE en la nube.

Palabras clave: Inteligencia de Negocio; Cloud Computing; PYME; Marruecos; Cifrado Homomórfico.

INTRODUCCIÓN

The use of cloud Business Intelligence (BI) has been highly skilled at the level of economic growth of most Companies, over the last five years. As the use of cloud BI is one of the essential determinants for success in business intelligence .In 2018, the level of adoption doubled to double that of 2016 (Around 66 % of prominent

business intelligence firms are truly cloud-based),[1] which global research anticipated years ago according to a study performed by IBM in 2011, that more than 60 % of organizations will accelerate their use of cloud computing in the future, in order to boost their competitive position in the labor market. So, since small and medium-sized businesses are the backbone of any economy, and the latter's success is based on their success, then the success and prosperity of these businesses can only be attained by implementing and adopting Cloud BI. Nevertheless, most developing countries, including Morocco, lack the courage to fully fund cloud-based BI technology and focus on making it an integral and inseparable part of the information and communication technology sector, as well as integrating it into all sectors (education, agriculture, tourism, economy, and so on). Morocco acknowledges the critical role that small businesses play in the nation's economic development, as seen by the 2020 launch of the "INTILAKA" program by the Royal Monarch of Morocco. However, to fully realize this, technical integration based on contemporary technologies like Cloud BI is still necessary. Particularly considering that the latter term combines two well-known terms: cloud computing, which is a platform for offering online computer services. and business intelligence, which is highly popular among organizations and help officials to understand business data with the goal of making smart business decisions. In light of this, cloud-based business intelligence presents a viable substitute by giving middle-sized businesses access to strong analytical instruments and data storage capacities.

In this paper, we use Morocco as a model for developing nations and suggest that small and medium-sized businesses (SMEs) should embrace the cloud BI, with the support of relevant government authorities, in order to encourage these companies to grow, which appear was greatly affected by the repercussions of the COVID pandemic and the Ukrainian crisis. in part 2, we covered the concept of cloud computing, its services, and the benefits this technology offers as we spoke about the concept of BI, its steps and structure.

Cloud Computing

The revolutionary concept of cloud computing encompasses the provision and use of online computing power. This approach transforms the software into a service where customers do not pay a fixed license, but pay according to their actual use. Thus, computing power and storage space are transformed into flexible resources, adapted to specific needs and scalable accordingly.[2] This cutting-edge technology provides organizations with access to IT resources via the Internet,[3] according to Gartner's vision, which defines it as an IT model where capabilities are delivered as an extended service via Internet technologies to meet the needs of many external users.[4]

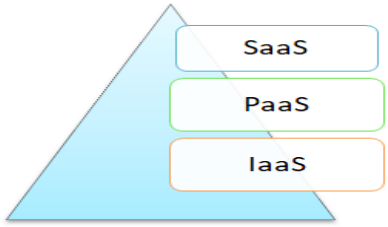

Figure 1. Cloud services pyramid

Cloud Computing Services

Three types of services are offered by the cloud computing architecture,[4] It can be represented in the form of a pyramid, starting with its top, from the most expensive to the least expensive, according to what the provider manages to facilitate the customer's needs (figure1):

• Infrastructure as a service (IaaS): system admins and network architects typically use this service to install their software at a low cost and build solutions on it. Customers may handle the installation, configuration, and updating of the operating system, intermediate software, and applications by managing the virtual and physical machines provided by this service provider, which are all tailored to the needs of the client.[5] In general terms, Infrastructure as a Service (IaaS) encompasses all services related to IT infrastructure, including virtualization, servers, storage and networking. This category of service gives customers the flexibility to customize and manage their cloud infrastructure based on their specific needs.[4] Providers of this service include players such as Amazon EC2 and Google Compute Engine (GCE).

• Platform as a service (PaaS): this service is primarily adopted by software developers and remains one of the most widely used in the cloud. It offers a full range of solutions and software that simplify the application creation process, providing an automatically assigned out-of-the-box environment, eliminating the need for

manual configuration from the customer. In this context, the user focuses exclusively on managing data and application resources, while the provider supports the entire cloud infrastructure, including virtualization, servers, storage, networking, operating system, middleware, and runtime. Some notable providers of this service include Aws Elastic, Beans stalk, and App Engine.[6,7,8]

• Software as a service (SaaS): this service is said to be the most customer-friendly because customers have no responsibility for the equipment, whether physical or virtual, or associated maintenance issues. It offers the client a ready-to-use application, without having to manage anything. The monthly or annual subscription fee, determined by the contract agreed between the company or organization, the customer and the service provider, is the only concern of the customer. Some of the service providers include Office 365, Salesforce, Gmail, Google Drive, and OneDrive.

Cloud Computing Features

Some distinctive aspects of cloud computing include:

• Resource pooling: cloud service providers have the ability to pool their IT resources, making them available to multiple customers. These resources, both physical and virtual, are dynamically allocated and reallocated based on changing needs.

• Fast Elasticity: cloud resources can be quickly adjusted, either up or down, to meet fluctuations in demand This flexibility allows users to pay only for the resources they actually need at any given time.[9,10,11]

• Wide network access: cloud services are accessible via the Internet from anywhere and from any device connected to the Internet. This provides accessibility without geographical constraints, promoting collaboration and mobility.

• Deployment Models: there are four main cloud deployment models: private cloud, public cloud, hybrid cloud, and multi-cloud. Each of these models offers specific advantages depending on the needs and requirements of the company.[12]

• Self-Service on Demand: users have the ability to provision IT resources on demand, such as servers, storage and applications, without requiring direct interaction with the service provider. This allows for greater autonomy and more efficient use of resources.

• Measured service: cloud service providers have the ability to monitor and measure resource usage. This feature allows users to pay only for the actual amount of resources they consume, thus offering pricing based on actual usage.[13] In short, cloud computing offers businesses a flexible, scalable and cost-effective approach to accessing IT resources and services, eliminating the need to invest heavily in expensive hardware and software.

Business Intelligence

Business intelligence (AI) represents a convergence of hardware solutions and software tools, encompassing various technologies and operations. Both a methodology and a product, it encompasses the recording and analysis of data, thus facilitating decision-making for a diverse clientele, including organizations and academic associations.[14] This approach involves a variety of methods that companies use to generate actionable data, contributing to their success and allowing them to confidently anticipate the actions of their competitors. [15,16,17,18] The BI system is made up of particular elements, and it is as follows:

• Data Warehouses: a data warehouse is a centralized database designed to accumulate and store data from diverse sources, including substantial volumes of historical data. The information within a data warehouse is typically organized to facilitate analysis and streamline decision-making processes.

• ETL (Extract, Transform, Load) Tools: ETL tools refer to software that extracts data from various sources, transforms it into a standardized format, and loads it into a data warehouse or another storage system. The automation of the data integration process with ETL tools can reduce errors and expedite processing.

• Visualization Tools: visualization tools are software applications used to create graphs, dashboards, and other forms of data visualizations. They enable the concise and straightforward presentation of data, facilitating the identification of trends, patterns, and anomalies. These tools are commonly employed for analyzing business, scientific, and social data.

• Multidimensional Analysis: multidimensional analysis is a method for visualizing data in multidimensional tables. This approach allows data to be categorized based on multiple dimensions, such as time, geography, product, etc. It is frequently utilized in the analysis of commercial data, including aspects like sales, revenues, costs, and more.

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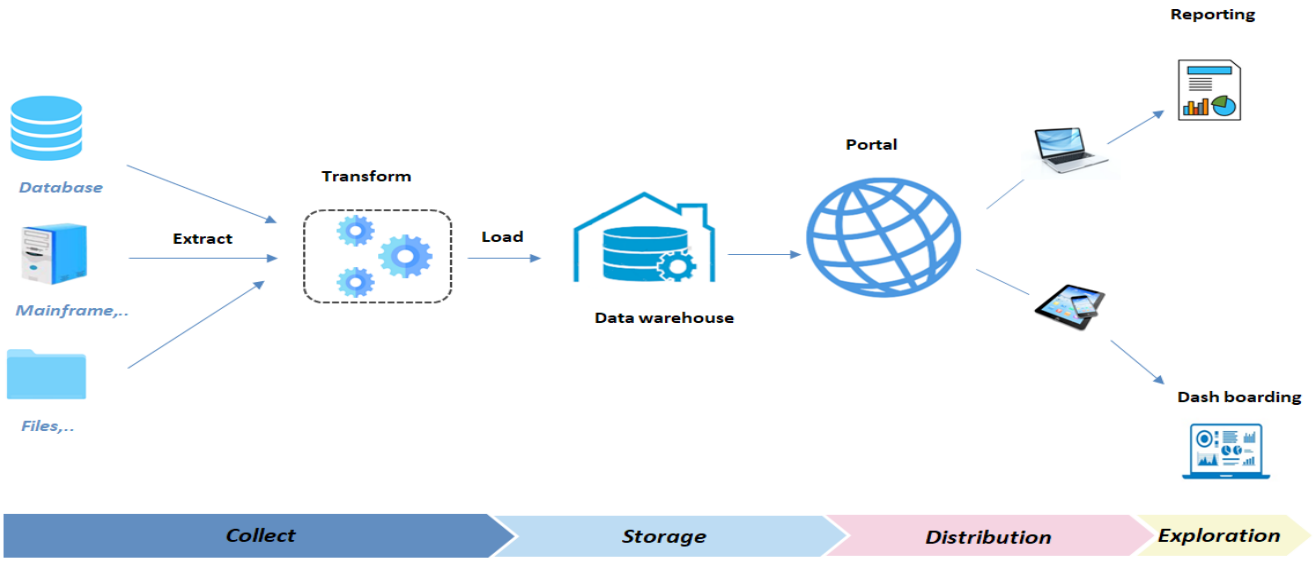

Figure 2. Business Intelligence (BI) steps

Business Intelligence Steps

Collecting, storing, analyzing and presenting data (exploration) is considered the popular steps (figure 2) in business intelligence. in phase of collect entails gathering and extract raw data from various sources, whereas phase of storage is converting raw data into useable data and storing it in a database, followed by the last phase that is the step of the exploration where data are analyzed then displaying the information that has been derived from it in the form of reports, dashboards, or visualisations, this last one, which in turn is being used for decision-making.[18,19,20]

Business Intelligence Architecture

• Data Layer: at the foundational level, the Data Layer assumes responsibility for the comprehensive management of raw data derived from diverse sources (CRM, ERP, etc.). This involves the gathering, organization, and storage of data, with a common repository being a data warehouse.[21,22,23]

• Logic Layer: positioned above the Data Layer, the Logic Layer is pivotal in the transformation of unprocessed data into actionable information tailored for business applications. This stratum entails intricate processes such as data cleaning, conversion, and aggregation, all geared towards preparing the data for the generation of comprehensive reports, interactive dashboards, and sophisticated analytics.[24,25,26]

• Presentation Layer: situated at the apex of the architecture, the Presentation Layer is dedicated to delivering business information to end users in a comprehensible format. With the aim of facilitating informed decision-making, this layer presents refined and processed data through a variety of mediums, including reports, dashboards, charts, and visualizations. The emphasis is on providing users with intuitive and accessible insights to enhance their decision-making capabilities within the BI framework.[26,27,28,29]

Cloud BI

Cloud Business Intelligence (BI) represents the contemporary approach to conducting BI operations. Instead of installing and managing expensive and intricate BI software on-premises, Cloud BI hosts BI applications in the cloud. This eliminates the need for users to invest in hardware or go through the complexities of software installation. Moreover, Cloud BI is conveniently accessible through any web browser.

The service operates on a pay-as-you-go model, allowing users to only pay for the resources they consume. This stands in stark contrast to traditional BI systems that require constant preparation for high-load utilization, making them both costly and challenging to access. The key advantage of Cloud BI lies in its scalability, as the system automatically allocates additional resources as user computing demands expand. This elasticity of scale not only enhances cost-effectiveness but also simplifies access to BI, making it more user-friendly and affordable compared to the traditional on-premises BI solutions.[10]

Migration of BI to the Cloud

The migration of Business Intelligence (BI) to the Cloud involves the process of moving BI applications and services from on-premises infrastructure to a cloud-based infrastructure. This encompasses the transfer of data, applications, and other resources from local servers to servers hosted in the cloud.[22] This migration

offers advantages such as scalability, flexibility, and cost savings. Furthermore, transitioning from on-premises BI to the cloud may include the adoption of cloud-based BI tools and services, introducing additional features and capabilities to enhance overall functionality.

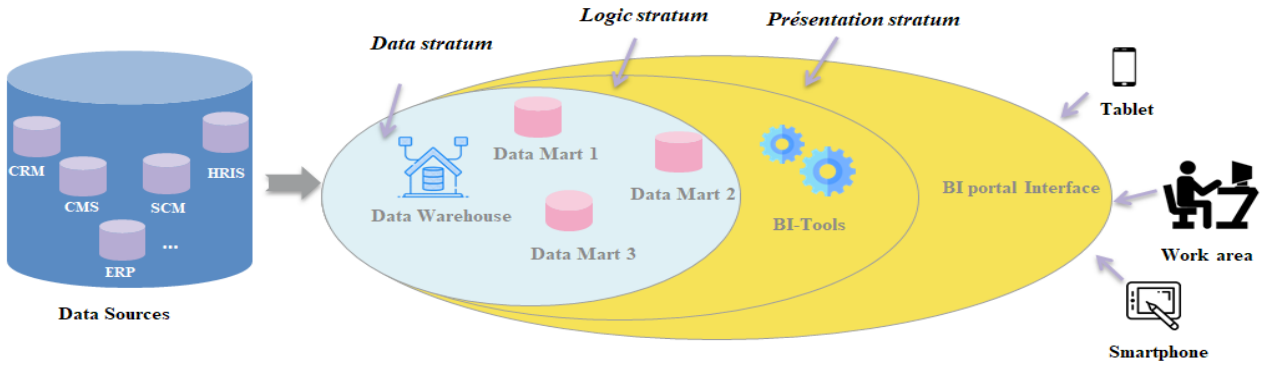

Figure 3. Non-cloud-based BI system (the generalised system)

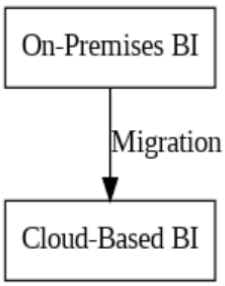

Figure 4. Visualizing Business Intelligence Migration to the Cloud: a Flowchart Illustration

Morocco, SMEs & Cloud BI. Important Stats and discussions

Small and medium-sized enterprises (SMEs) represent the backbone of the national economy, playing an essential role in its dynamism. The economic prosperity and well-being of citizens are intrinsically linked to the performance of these companies. It seems that Morocco recognizes the crucial importance of SMEs, which motivated the acceleration of the implementation of various support programs, including the "Intilaka" program. The objective of this program is to provide financial support to businesses, by granting them loans, to help them overcome the challenges caused by the COVID crisis. This crisis has had a significant impact on the global economy, with serious economic and social consequences in many countries, including Morocco.

It is important to note that small and medium-sized enterprises (SMEs) play a crucial role as the main source of employment, with small businesses accounting for 85,5 % and employing nearly 73 % of the workforce. To illustrate the impact of these entities, we use 2018 data, where a study covered a population of 208 919 institutions. Of these, 748 207 were small and medium-sized enterprises, making up 99,4 % of the total, with 85,5 % micro-enterprises and 8,1 % very small enterprises. Large firms accounted for only 0,6 % of the total.[29]

The figure below provides a visualization of the distribution of establishments by size of enterprise size (Very Small Business (VSP), Small Business (SB), Medium-sized Business (MB), Large Business (LB), Micro-business: a very small company, usually with fewer than 10 employees and an annual turnover below a certain threshold (Micro-business)) among of the total number of Active Legal Entities and it represents the total number of the total legal and active institutions (ALE):

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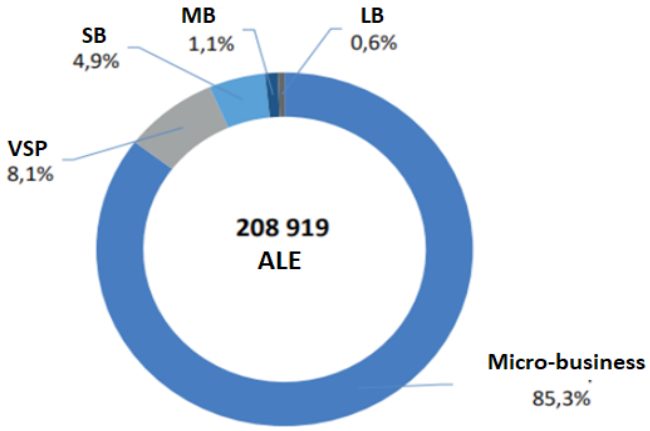

Figure 4. The distribution of institutions by business size[12]

This indicates that SMEs are truly the engine of the national economy. The key to effective solutions for the prosperity of these businesses and the economy as a whole is technology solutions. Indeed, technology is one of the main drivers of nations' economic development. SMEs, although they remain competitive, must adopt the latest technological advances in order to continue, otherwise they risk failure. In this context, the BI Cloud holds a prominent place, having enabled many mid-sized companies in other countries to rapidly boost their economic growth (99 % of all companies in North America and Europe).[2] This progress is based on business intelligence as the main ally and on basic technology for crucial decision-making. Cloud computing, as an essential component, confers a set of advantages. However, the success of this transition requires not only government financial support, but also collaboration with regional telecommunications operators. Indeed, the implementation of this technology, which is the BI Cloud, requires not only funding programs, but also the implementation of essential ancillary structures and technologies.

Benefits of cloud BI in SMEs

The integration of Business Intelligence (BI) in the cloud offers a set of significant strategic and operational benefits to small and medium-sized enterprises (SMEs), as detailed below:[14]

• Cost optimization: migrating to cloud BI frees SMEs from the high upfront costs associated with purchasing expensive hardware and software. In addition, ongoing maintenance and update expenses are significantly reduced. This cost optimization translates into substantial financial savings for SMEs.

• Scalability Flexibility: cloud BI provides exceptional scalability flexibility for SMEs. They can easily adjust the size of their BI infrastructure according to changes in demand, without being limited by local infrastructure constraints. This allows SMEs to effectively manage growth while maintaining operational agility.

• Enhanced Security: cloud-based BI providers are investing heavily in advanced security protocols. These measures often include data encryption, access and authorization management, and real-time threat protection. As a result, SMEs benefit from enhanced security, ensuring the protection of their customers' sensitive information. This proactive approach to security provides additional peace of mind for SMEs regarding the integrity and confidentiality of their data.

SMEs Concerns about using Cloud BI

Small and medium-sized enterprises (SMEs) frequently express significant concerns,[8] detailed as follows:

• Data Security: when adopting cloud computing, SMEs express major concerns about the security of their data. This apprehension is particularly related to the retention of data on the cloud, generating potential fears of loss or compromise of security.

• Data Privacy: SMEs fear the possibility of data breaches or illegal access when they opt for the cloud. They are also concerned about how their information might be used, and whether these uses comply with applicable laws. Data privacy is a critical concern in a digital environment where cyber threats are pervasive.

• Profitability: a major concern for SMEs is to ensure that the benefits of implementing cloud computing outweigh the costs incurred. The financial aspect is at the heart of their concerns, and SMEs are looking to carefully assess the potential return on investment before fully engaging in this technological transition. Profitability must be clearly demonstrated to justify the adoption of cloud computing.

Proposed Framework

Our conceptual framework draws its inspiration from a previous model presented in a study published in 2014,[16] which represents a specific case of Business Intelligence in the cloud (Cloud BI). This initial model focuses on migrating BI to the cloud. Our approach aims to address the limitations inherent in this previous framework, while fully taking into account the concerns of the companies mentioned in this document.

In our approach, we integrate the various factors that influence the overall decision to adopt Cloud BI, with a particular focus on migrating BI to the cloud. Our explanation is based on specific models and concrete examples, illustrating the feasibility of the results resulting from the application of the framework we propose (figure 3).

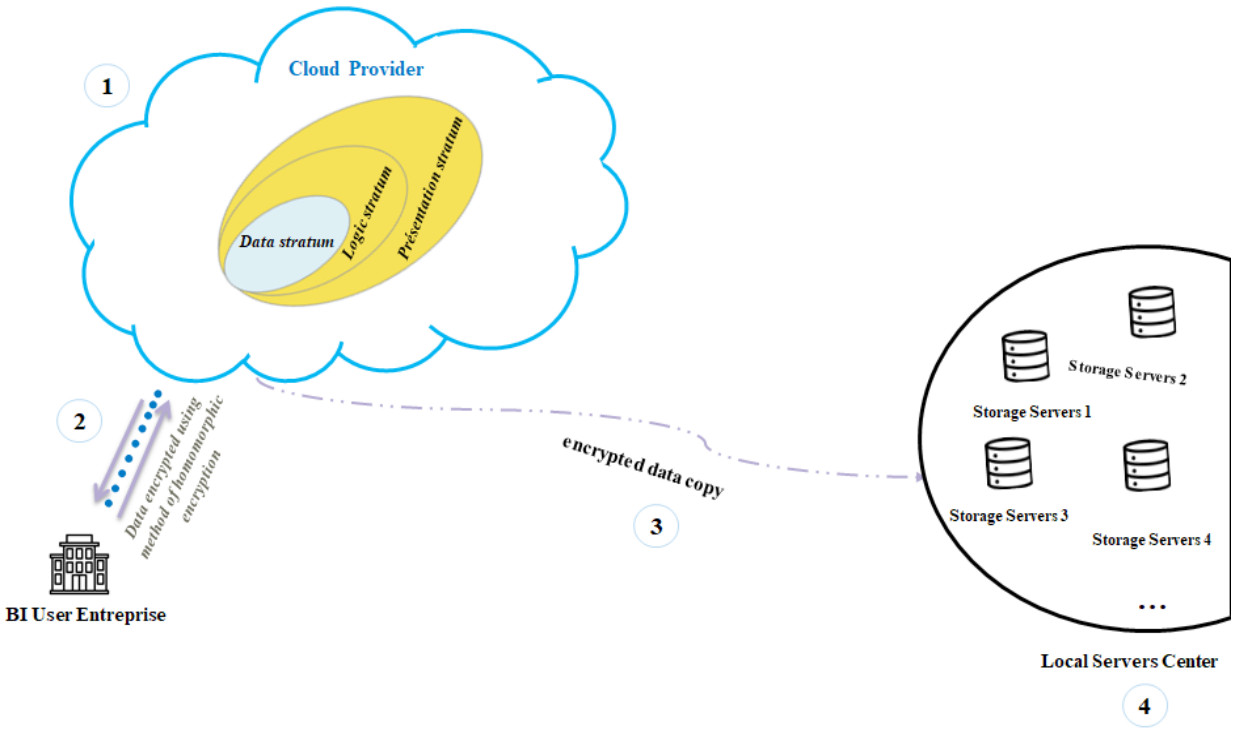

Figure 5. Schematic architecture of proposed framework (cloud-based BI system)

Once the Business Intelligence (BI) user transfers their data to the cloud, the BI (Logical Layer) tools activate to exploit the cloud environment, thus analyzing the data received and stored in the data warehouse. This approach allows a subsequent re-analysis of the data, which becomes easily accessible via the presentation layer (figure 2). The information is then presented in the form of reports and graphs via a BI portal interface. This interface offers end users a way to access data from various devices such as mobile phones. Modern BI portal interfaces are typically designed to be responsive and adaptable to different types of devices, ensuring users have a consistent experience across devices.

Our framework relies on a single vendor rather than multiple vendors, as the use of multiple vendors contravenes several fundamental objectives of IT integration. This is also a concern for organizations using these technologies, including:

• Cost: the use of multiple providers results in higher costs, depending on the type of service. Therefore, our approach aligns with this consideration by favouring the use of a single supplier.

• Data security and privacy: we recognize that the use of multiple providers can offer various data backups and strengthen the ability to cope with failures and disasters. However, this is seen as a privacy risk. Rather than having data exploited by a single provider, they could be accessible to many, increasing the risk of errors and problems. In an earlier study from 2014, the possibility of a partial migration was raised, involving the displacement of half the data while retaining the other half. However, this approach would inevitably lead to higher costs and a burden on users, especially if multiple infrastructures and providers were involved. Rather than focusing on managing multiple infrastructures, it is recommended that the organization focus on a single cloud infrastructure. This would simplify management by avoiding the need to manage various local and other cloud infrastructures.

Our system aims to overcome the challenges faced by small and medium enterprises, supporting data

security and reducing costs. It takes a single vendor approach to complete data migration. However, it places particular emphasis on adopting the latest encryption technologies, such as homomorphic encryption (which we will discuss later). It also stresses the need to formalize a contract under the supervision of the competent authorities between the supplier and the beneficiary company. This is to ensure that no one has access to the data without the appropriate permissions.

The system we propose also takes into consideration the possibility of data loss. Thus, we suggest the creation of a local server center.

A local server center equipped with an appropriate number of servers, adapted to the size of the organization's data. This would be overseen by the competent authorities and regional communication operators, offering companies a solution to ensure the security of their data. Copies of the data transferred to the cloud provider could be sent to the local host on a regular basis, enabling data recovery in the event of a disaster.

Homomorphic Encryption

We briefly present the security technology, homomorphic encryption, integrated into our framework. This technology establishes a high-level security infrastructure for cloud-based database storage and transfer. Figure 4 illustrates a schematic architecture adapted to the framework we propose.

Two levels have been incorporated into the design of this framework. The first level concerns the provider of basic data services, located in an unreliable public cloud. The second level represents the client (Enterprise), where a proxy client is deployed in the client environment. This proxy manages communication between client applications and the cloud-based database. When a client launches a request, the proxy transforms it into a chiseled request, executed directly in the cloud. Upon receiving the query results from the cloud, the proxy decrypts them before transmitting them to the client. The proxy is based on a metadata module containing the underlying data models and rounding and unbundling keys.[17]

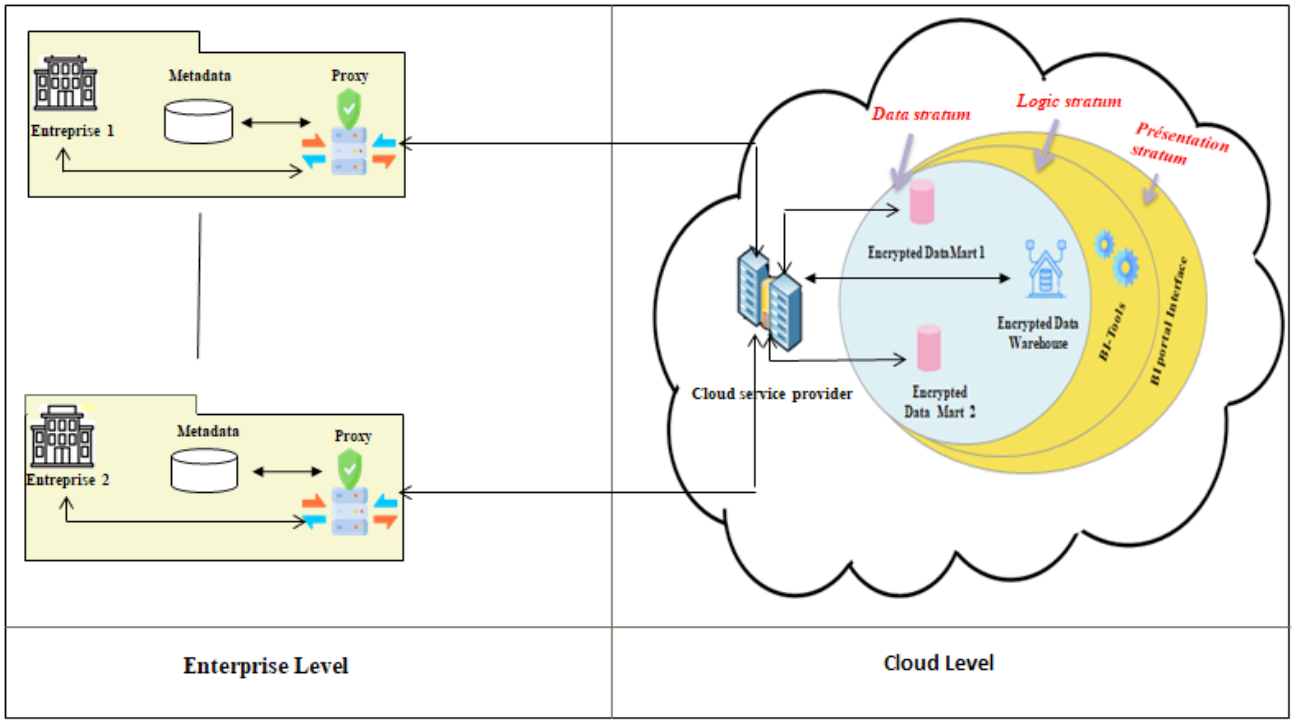

Figure 6. Shematic architecture suitable with the proposed framework

CONCLUSION & PERSPECTIVES

The purpose of the document was to present cloud-based Business Intelligence (BI) in general and to detail the process of migrating from BI to the cloud. The study explored the relationship between small and medium-sized enterprises (SMEs) and the national economy, concluding that the success or failure of the Moroccan economy rests on that of SMEs. A planning framework for the migration of BI to the cloud was proposed in the study, with an attempt to address the specific concerns of SMEs. However, it is stressed that this framework cannot guarantee the resolution of all concerns of companies, as these may vary according to the actual context and the type of service desired by the company and proposed by the supplier.

The study highlights the need to pay particular attention to these concerns, stressing that financing alone is not enough to improve the situation of businesses. It is imperative to support them in the integration of modern

technologies such as Cloud BI, a technology that has contributed to the prosperity of many companies.

Looking to the future, our study opens the door to additional contributions and perspectives. Our next step will be to rigorously validate our approach through detailed simulations of the migration from BI to the cloud. Pilot experiments, using datasets representative of Moroccan SMEs, will be launched to test the feasibility of our approach under controlled conditions before a broader implementation. These efforts are also aimed at making our framework more effective and offering it to other developing countries. We seek to generalize the idea that these small businesses play a central role in economic success, thus encouraging future research on other countries and the integration of other modern technologies beyond intelligence and cloud computing. Despite its national character, the economic structure can be compared to that of other nations, which would make it possible to generalize the rule established by our study.

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