**TITLE: EVALUATION OF ONLINE ANALYTICAL PROCESSING SERVERS (OLAP)**

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**ABSTRACT**

Online Analytical Processing (OLAP) is a business intelligence tool/server that provides a platform for the analysis of a multidimensional data and large volume of data in relation to speed and high query performance. OLAP help to solve both simple and complex analysis ranging from budgeting, forecasting, building, and developing models, predictive analysis through the multidimensional model and view. The main component of an OLAP server is the cube, which is an orderly arrangement of multidimensional data that enables the process and analysis of multiple data dimensions efficiently and quickly than a relational database. OLAP find applications in different business segment and sector from Finance, sales and marketing, manufacturing, and many more to enable business owners generate insights and make effective decision.

There are several OLAP tools available for business intelligence users in the market today, the tools come with different functionality and varying performance level due to the architecture and component of the tool. Hence, the need to critically evaluate these tools and the evaluation will be done by reviewing the basic criteria required for an efficient OLAP tools in order to aid user to determine the specific tool suitable for their business in line with the business requirement.

**KEYWORDS**

**Hierarchy**- This is the arrangement or the organisation of different levels of a particular dimension.

**Dimensions** – Dimensions are list of related attributes that revolves around a fact.

**Cube**- Is an arrangement of data in a multidimensional way that allows ease of query and analysis of the data. A cube is typically consisting of 3 or more dimensions. However, it can be constructed to an infinite number of dimensions.

**Architecture-** This is the component of OLAP, it defines the feature and the functionality that makes up the tool.

**Aggregations-** This is the computational analysis of the dimensions in the OLAP i.e., the combination of one or more dimensions together through analytical and modelling computation.

**SSL-** Secure socket layer that provides encrypted link between client and server, it allows for secure transmission of data ( *DigiCert*, no date)

**PDF-** Portable Document Format

**XML-** Extensible Markup Language

**HTML-**Hypertext Markup Language

**CSV-** Comma Separated Value

**On the Fly-** This is the modification of a process while the process is on-going

# **DESCRIPTION OF CRITERA FOR EVALUATING OLAP TOOLS**

There are numerous OLAP tools available in the industry today and they serve different applications due to their architecture and functionalities. However, to determine an effective and efficient OLAP tool required for generating business insights based on requirements, the following criteria have been identified as essential in evaluating OLAP tools.

**Multidimensional View of Data:** This criterion engages a multidimensional model which allows logical views of two or more dimensions of data from the database system. This feature of OLAP tools allows application on complex systems such as healthcare systems via flexible access to corporate data.(Priya Pedamkar, 2020). This feature also saves users from the syntax of complex queries and provides consistent response times for all queries, no matter how complex.

**Flexible Reporting:** The OLAP tools must be highly versatile to accommodate user ingenuity in report generation and the well-defined segregation between the data sources and the reporting component for effective reporting and insight generation.

**Excellent Query Performance:** OLAP tools are mainly used for large and complex data analysis and as such, the query performance of the tools as well as the reporting performance must be consistent irrespective of the number of dimensions. The performance of the tools is expected to remain active and consistent as the number of dimensions increases or as the data volume increases.

**Accessibility/Interface:** A user friendly interface, that allows for ease of use of the tools to create simple and complex analysis along with data modelling. The OLAP tools must be able to allow user to access data needed for analysis from all available sources, relational, non-relational, legacy system, structured of unstructured data.

**Data Security:** The privacy and security of data is an essential part of an OLAP tools, as the business user must have confident in the security of the data loaded into the system and detailed encryption and access security must be put in place to ensure the security of data.

**Efficient and Detailed Aggregation Support:** Business users uses OLAP mainly to analyze large complex data which requires complex analysis such as budgeting, forecasting, financial models, and predictive functions which would be achieved through unlimited aggregation options. The tools must be able to accommodate unlimited dimensions and multiples hierarchies for this complex aggregation to be carried out.

**Basic Dimensional Operations:** OLAP tools should be able to perform basic dimensional operations such as roll-up, drill-down, slice’n’dice and pivot which is essential for transformation and manipulation of data to suit the user’s requirements(Connolly *et al.*, 2014). The ability to look up data differently as the user deems fit is an essential criterion for selecting an OLAP tool.

**Multi-User Support:** OLAP tools should be able to support different users at the same time and the performance, integrity and security of the server, tools and accessibility must not be compromised. Every user should have the same level of performance while working with the tools.

# **INVESTIGATION OF AVAILABLE COMMERCIAL OLAP TOOLS IN THE MARKET**

We have carefully reviewed and evaluated seven (7) OLAP tools commercially available in the market today in line with the criteria highlighted above for the evaluation of OLAP tools.

**MICROSTRATEGY:** MicroStrategy, as a hybrid online analytical processing tool, has the capability to generate queries or SQL in many relational databases, which include Redshift, Oracle, Teradata, SQL Server, and others. With the aid of cube structures, it can also function as a MOLAP (multidimensional online analytical processing). It is a Business Intelligence enterprise analytics and reporting software with high generation of complete and clear reports, which supports interaction of dashboards, scorecards, high formatted reports, distribution of automated reports, alerts, and so on, linking to the generation, systematic arrangement, and reports that give track of past, current and future performance of business(Technologies, 2021).

**ORACLE OLAP:** The Oracle OLAP multidimensional analytical engine is a built-in feature of the Oracle BI enterprise version 12c database(‘Oracle White Paper’, no date). It allows for the central management of data and business rules on a secure platform. Oracle OLAP’s ability to construct analytical measures including time-series calculations, forecasts, financial models, allocations, regressions, and many more means that almost any analytical calculation requirement may be satisfied or made(Connolly *et al.*, 2014). Due to the star schema architecture that surrounds the cube (fact) view, which is how the OLAP cube is displayed, any reporting and analytic tool may readily interact with and function successfully with the Oracle OLAP.

**APACHE KYLIN:** An open-source distributed analytics engine called Apache Kylin was created by eBay Inc. to support extremely big datasets with multi-dimensional analysis (OLAP)(*Apache Kylin | Apache Kylin4 — A new storage and compute architecture*, no date) on Hadoop/Spark. Some of the well-known products that integrate with Apache Kylin include Apache Spark, Hadoop, Tableau, Superset, and Power-BI. Compared to row-based storage formats, it uses a column-based storage format, which improves query performance.

**PALO OLAP SERVER:** Palo was said(‘Palo - business intelligence tool’, no date)to be an in-memory MOLAP type server is Palo OLAP Server. Real-time modelling is supported by Palo OLAP Server. This indicates that users may quickly alter hierarchies and even build new cubes in the comfortable Excel interface. New aggregated values are promptly returned by the database. Palo makes it possible for several people to share a single, central data store. It utilizes data that is current. Using multidimensional queries, data may then be consolidated or written back. Palo keeps run-time data in memory so that users may access it more quickly.

**TABLEAU:** Tableau is a BI and analytics solution that helps with the analysis of crucial company data and the generation of illuminating conclusions. A single dataset may be created using the technology by combining data from several sources, such as spreadsheets, cloud apps like Google Analytics and Salesforce, SQL databases, and spreadsheets (Bhombe *et al.*, 2019). Data may be transformed into useful insights with the aid of Tableau. It is a solution for visual data analytics that makes data management easier for businesses.

**IBM COGNOS:** IBM, A reporting and analytical tool that is web-based is called Cognos Business Intelligence. It is used to aggregate data and provide user-friendly, in-depth reports. Graphs, several pages, distinct tabs, and interactive prompts are all possible in reports. Web browsers and mobile devices like tablets and smartphones may both be used to see these reports. Additionally, Cognos gives you the choice of viewing reports in XML format or exporting them in XML or PDF format. It saves time to read the daily report since you don't have to run the report each time if you plan it to run in the background at a certain time.

# **ARCHITECTURE AND FUNCTIONALITIES OF THE SELECTED OLAP TOOLS**

**MICROSTRATEGY (Technologies, 2021) , (‘OLAPServicesGuide.pdf’, no date)**

**ARCHITECTURE**

* Data warehouse which stores objects created.
* Dynamic MDX engine for generating multidimensional expressions.
* Dynamic SQL engine for analysis
* Unified Metadata
* MicroStrategy Intelligence Server which performs the core analytical processes.
* MicroStrategy Web serves as the reporting platform.

**FUNCTIONALITIES**

* An HOLAP tool with SQL analytical functions.
* Analyzing Big and Complex Data
* Integration with all database and client architecture and all apps and systems used.
* Advanced Predictive Capabilities.
* Access to all data type of data and data sources
* Data Mining and Data Modelling features
* On the fly aggregation, analysis

**ORACLE OLAP (‘Oracle White Paper’, no date****)**

**ARCHITECTURE**

* Embedded in ORACLE database enterprise editions.
* Analytical Workspace Manager (AWM) used for managing objects in the OLAP engine.
* Oracle Warehouse Builder (OWB) used for creating multidimensional cube for analysis.
* Supported query platforms such as SQL, PL/SQL or MDX languages.
* Java based Programming interface.
* Oracle OLAP spreadsheet for modelling and computations
* OLAP DML is used for transformation and manipulation using different forms of Aggregations.

**FUNCTIONALITIES**

* A MOLAP server
* JAVA API
* High Query Performance
* Support complex multidimensional calculations.
* Integrated OLAP Administration
* Excellent Data Management
* Support for both Oracle relational tables and multidimensional data
* Support for all analytical calculations and modelling
* Unlimited hierarchical support of dimensional data

**APACHE KYLIN**

**ARCHITECTURE**

* Open-source Distributed Analytics Engine designed to provide SQL interface and multi-dimensional analysis on Hadoop/Spark and supports large datasets
* Collects sourced data through Hive/Kafka for extraction and loading.
* Build Cube with MR/Spark
* Pre-calculates and stores CUBE data in HBASE for high performance and scalability.
* Serves real time with ANSI SQL

**FUNCTIONALITIES**

* Supports numerous interactive queries at the same time with low resource consumption per query.
* Easy definition of multi-dimensional model and pre-calculation of the cube via Kylin.
* Provides flexibility in choosing different engines for different data sets.

**PALO OLAP SERVER**

**ARCHITECTURE**

* Supports numerous interactive queries at the same time with low resource consumption per query
* Easy definition of multi-dimensional model and pre-calculation of the cube via Kylin.
* Provides flexibility in choosing different engines for different data sets.

**FUNTIONALITIES**

* Mobile application that allows checking of real-time dashboards, reports and perform ad hoc data analysis.
* Supports web-based applications for data analysis and modeling, reporting, 3rd-party integration, and pre-built application models.
* Client Libraries for C/C++, Java, .NET, PHP.
* Multi-dimensional expressions (MDX) and APIs for connectivity.
* XML for Analysis.

**TABLEAU**

**ARCHITECTURE**

* Data Source which combines several data sources and establishes remote connections to them.
* Data Connectors include fast data engine, MDX connector which deals with the cubes, SQL connector and data repository.
* VizQL server which is visualization query language.
* Application Server accepts user requests for visualization.
* Data Server monitors the data connectors.
* Client’s layer is the reporting segment for the process data and visualizations.

**FUNCTIONALITIES**

* Provides high-speed real-time data analysis and simplicity of update to newer models.
* Integrates live dashboards in portals like Salesforce or a SharePoint site and filter, sort, and discuss data in real time.
* Uses Data Interpreter to interpret or extract data from Excel, CSVs, Google Sheets, and PDFs.

**IBM COGNOS**

**ARCHITECTURE**

* A multilayered Architecture made up of three server tiers: Web Tier, Application Tier, and Data Tier
* The Web tier facilitates the user connection to the IBM COGNOS BI applications through the Cognos Gateway
* The Application Tier contains three serves: dispatcher, report server and content manager.
* The data tier contains the Content Store, a relational database that contains the data required and Data Sources which allows access to relational databases, dimensional and OLAP cubes.
* Uses SSL for data transmission security.

**FUNCTIONALITIES**

* Performs multilingual capabilities, i.e., automatically delivers reports in the users' working language.
* Delivers Fast results, i.e., shortens reporting time due to seamless integration and adaptive authoring.
* Flexible reporting interface, i.e., deploys in cloud or on premise.
* Efficient data exploration and data preparation with AI
* Engages multiple export formats—Excel, Portable Document Format (PDF), Extensible Markup Language (XML), Hypertext Markup Language (HTML), and Comma Separated Value (CSV).

1. **CRITICAL EVALUATION & COMPARISON OF THE OLAP TOOL**

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# **BUSINESS SCENARIO**

OLAP tools are essential tools needed in analyzing large complex data to generate insights. A retail business is a perfect example of a business that involves the use of large complex data to generate business insights for business development.

In the above selected tools, we have identified **MICROSTRATEGY** as the best tool amongst other tools in answering key questions due to its functionality and architecture. This will be examined with a business case of **MS INC.**, A retail company that specializes in the sales of groceries product to households, with an online presence and over 100 outlets within the UK. The business manager of the company is looking to incorporate the use of an OLAP server into the Business Intelligence structure to enable them to generate fast reports and insight that will help develop and improve their sales output. The main concerns to be address by the company in selecting their OLAP tools are:

* Key Functionalities such as performance and storage
* Data Security
* System limitation (data access)

MicroStrategy is highly recommended due to its “on the fly” functionality that allows you to not only pull a very large amount of data from different sources but also allows you to work through other tasks while the process is ongoing, (*MicroStrategy Analytics Software Reviews & Ratings | 2023 | Software Advice*, no date). MS INC. requires a tool that will enable access to large amounts of complex data without glitches and MicroStrategy helps solve this important requirement. In addition, MS INC. is looking to use an OLAP tools that offered a great deal of data security as they are going to be dealing with critical customer information such as credit card details, personal information and others and in line with GDPR policy, it expected that customer’s data are safely secure. MicroStrategy offers high security solutions as a result of its high-level network encryption using SSL and AES and also detailed Authentication in host, database using NTLM, Microsoft Active Directory. (‘Comparison of OLAP servers’, 2022). MicroStrategy has an unlimited level of dimensions, cubes and hierarchies which will enable MS INC. to access and analyze unlimited large datasets, which is typical of a retail business. Above all, MicroStrategy utilizes Hybrid OLAP servers (HOLAP) which allows for both relational data and multidimensional data for a fast query processing performance and high scalability.

Generally, the distinctive features that make MicroStrategy more suitable for MS INC. as an OLAP tool are the security features, unlimited aggregations, and dimension levels, “on the fly” functionalities which are important features for a retail business.

# **FUTURE DEVELOPMENT OF OLAP TOOLS**

The continued development of OLAP servers from its first appearance to date is essential and as such helps makes OLAP remain in today’s changing business world. The idea of organizing data using dimensions and hierarchies is still in use because it offers security (‘BI present: OLAP future and alternatives’, 2019), which is important in today’s world where greater emphasis are placed on data protection and security. In sustaining the future of OLAP tools, the following future developments are recommended.

**Cloud OLAP;** this will be essential as the changing business environment is accommodating more cloud-based platform as more data are stored in cloud and its essential that OLAP tools are developed to host OLAP serves on Cloud platform, as this will increase interactivity and improves performance while also becoming more accessible to users.

**Less reliant on technical capabilities**; OLAP tools should be looked to be developed to rely less on IT capabilities such that business users can analyze data, generate reports and visualization with less knowledge of the technical details required for the implementation.

**HOLAP;** More OLAP tools should be developed to with a Hybrid architecture as this will serves more business purpose and creates ingenuity for users and different solution route to problems.

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