
Business Intelligence

in Government Procurement

ABSTRACT

Over the years, Singapore's Government E-Business (GeBIZ) Portal has accumulated a knowledge base of procurement data. This data is a valuable source of market knowledge and intelligence. The paper will detail how Business Intelligence, via a three-pronged approach of Intelligent Procurement, Portfolio Management and Performance Management, has helped GeBIZ users exploit past procurement experiences to reduce turnaround time, increase productivity and ensure accountability of public funds.

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INTRODUCTION

Launched in 2000, the Government Electronic Business (GeBIZ) Portal is an integrated portal for use by all Singapore government agencies to conduct business electronically with their suppliers. There are more than S\$10 billion worth of business opportunities published annually to 30,000 suppliers registered with GeBIZ.

Over the years, GeBIZ has accumulated a knowledge base of procurement data. This data is a valuable source of market knowledge and intelligence. To exploit this untapped source of information, a Business Intelligence (BI) platform was introduced to help improve the efficiency and effectiveness of government procurement and raise it to a more strategic level of intelligent sourcing and purchasing. This paper will detail how BI has helped users of the GeBIZ Portal reduce turnaround time, increase productivity, ensure accountability of public funds and highlight the challenges in the implementation.

BUSINESS INTELLIGENCE

The term 'Business Intelligence' dates back at least half a century when Hans Peter Luhn defined it in 1958 as:

"... business is a collection of activities carried on for whatever purpose, be it science, technology, commerce, industry, law, government, defense, et cetera. The communication facility serving the conduct of a business (in the broad sense) may be referred to as an intelligence system. The notion of intelligence is also defined here, in a more general sense, as "the ability to apprehend the interrelationships of presented facts in such a way as to guide action towards a desired goal." (Luhn, 1958)

Broadly speaking, BI describes a framework of policies, concepts and methods (Power, 2007)



realised by a system of tools for gathering, storing, analysing and providing access to data to help organisations make better business decisions faster. BI systems today comprise a set of tools that can typically perform reporting, budgeting, statistical analysis, data mining, forecasting and visualisation. These tools revolve around a data warehouse to facilitate informed and cross-business decision making in Supply Chain Management, Business Process Management, Customer Relationship Management, Enterprise Resource Planning and other related business processes throughout an organisation. These tools extract facts and metrics from raw transactional data as well as processes and integrate them into a consistent information schema. This enables users to analyse information collaboratively, gaining insightful situation awareness to make informed decisions.

THE BUSINESS

With these notions in mind, the project team envisaged that BI could be harnessed to bring about significant improvements in productivity and effectiveness in Government Procurement through:

- **Intelligent Procurement** – BI can be used to extract market intelligence on suppliers, products and procurement activities, enabling buyers to make intelligent decisions

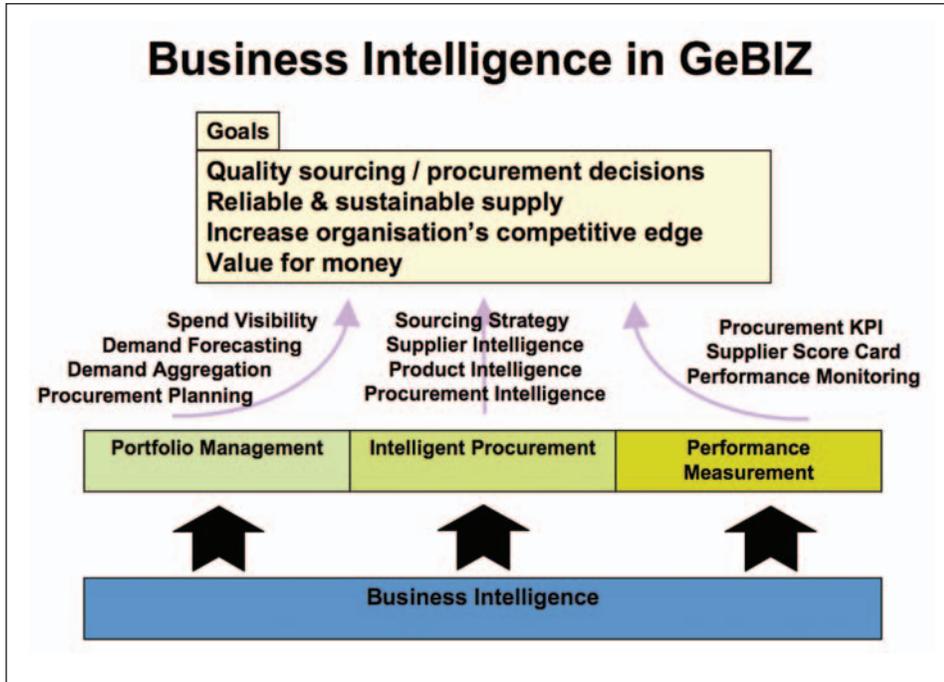


Figure 1. Overview of Business Intelligence components within GeBIZ

throughout the procurement process. With significant market intelligence at their fingertips, buyers will be able to develop better sourcing strategies.

- **Portfolio Management** – BI can also provide overall visibility of spending patterns, facilitate demand forecasting and aggregation as well as assist in procurement planning.
- **Performance Management** – Lastly, BI can help monitor procurement service level, policy compliance, supplier performance and measure procurement efficiency.

Conceptually, Intelligent Procurement involves the use of BI at the operational level to facilitate individual decisions on specific procurement activities. On the other hand, the application of BI in Portfolio Management and Performance Management addresses Government Procurement at the management level. With the overall visibility of government and organisation-wide spending, BI can move

Government Procuring Entities (GPE) up the procurement value chain from a transaction-centric model to one that is proactive, collaborative and efficient.

DEVELOPMENT OF BI IN GEBIZ

The development of BI in GeBIZ started in early 2006 when the Ministry of Finance (MOF) felt that GeBIZ had matured and stabilised since its inception. GeBIZ BI initiatives can be broadly divided into two areas. The first area entails the development of GeBIZ InSIGHT which is a tool developed internally that leverages Artificial Intelligence (AI) to deliver a set of BI tools, which enables individual procurement users to research historical buys to gain market insights for Intelligent Procurement. The second portion covers the development of GeBIZ Management Console (GMC). GMC enables macro-level portfolio management and performance management in the public sector.



GeBIZ INSIGHT

GeBIZ InSIGHT was made available to all public sector agencies in December 2006 to allow procurement officers to mine all of the then unavailable transactional data stored within GeBIZ portal. Designed to be pervasive and available to all, it is embedded into the procurement officers' workflow. By providing the best suggestions and alternatives if required, it helps the officer make intelligent and cost-effective decisions in their daily work. This tool, through the provision of advice as and when needed, could turn an average purchasing officer into a highly informed and efficient buyer. For example, GeBIZ Portal can now suggest to the purchasing officer how to classify the procurement category of his transactions and even recommend suppliers suitable for his current procurement objective based on their history.

GeBIZ InSIGHT allows users to:

- Research past tenders, quotations and period contracts of similar purchases across the entire public sector to determine prices
- Extract purchase references, documents, specifications and requirements of similar purchases. This information will help buyers plan and structure future purchases and source for reliable suppliers.
- Appraise suppliers by retrieving supplier financial information and transactional history
- Evaluate current tenders and quotations by guiding buyers through the tender/quotation evaluation process in a step-by-step manner. Information on similar historical purchases and suppliers are also extracted for buyers to refer to.
- Recommend appropriate procurement categories and suggest possible suppliers to invite during the tender notification process

With the success of GeBIZ InSIGHT, the project team embarked on the next phase of BI development in June 2007, named GeBIZ Management Console.

GeBIZ Management Console

GMC involves a platform that integrates a set of BI methodologies such as Online Analytical Processing (OLAP), Data Visualisation and Data Warehousing to provide decision makers in various government agencies with intuitive access to effective Portfolio Management and Performance Management.

Some key capabilities of GMC include:

- Providing overall spend visibility of government procurement
- Demanding forecasting and identification of potential areas for Demand Aggregation (DA) across the public sector
- Facilitating the establishment of customised procurement Key Performance Indicators (KPI) for individual agencies and the entire government

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IMPLEMENTATION CHALLENGES

The business of government procurement differs significantly from that of commercial entities. For example, commercial entities are segmented by their potential value for targeted marketing campaigns. Preferential treatment of different customer segments is a norm in commercial practice. Government procurement is different by nature: it has to operate based on the principles of openness, fairness and transparency.

Most BI solutions in the market today are built with commercial applications in mind, and their fundamental principles are different. There is a lack of expertise and off-the-shelf solutions for government procurement. The project team has to do its own research and develop the BI solution for government procurement from first principles. The major challenges encountered are discussed here.

Classification

GeBIZ Portal was originally built to facilitate transactional activities such as Tenders and Quotations. These transactions were not classified into detailed categories for analysis. The result is a database of millions of transactions but without the means to determine what was bought or sold. The mitigating approach was to partition the data by taxonomies such as IT Equipment, Transportation as well as Building and Construction. These categories were derived from the Procurement Supply Heads from MOF and the Building and Construction Authority in consultation with DSTA as well as other GPEs.

An off-the-shelf and in-database AI engine based on the Support Vector Machines algorithm was customised and deployed to address this classification problem. With the

help from cataloguing specialists from the Singapore Armed Forces Cataloguing Authority, 25,000 record samples in GeBIZ were extracted and manually categorised. These sets of categorised records called 'training sets' were used to train the initial AI engine to categorise all historical transactions in GeBIZ. By observing thousands of public officials conduct their daily procurement tasks, the engine automatically learnt and corrected its previous mistakes and also discovered new categories as they arose.

However, a classification engine is ineffective if it cannot understand the unstructured information within each procurement transaction. For example, the system needed the capability to know that printing paper and watermarked paper, specified by different procurement officers, are both paper purchases. It also had to be able to distinguish the difference between the word 'plane' in e.g. a 'woodwork *plane*' and an '*aero-plane*'. To address this contextual and disambiguation issue, the project team applied Natural Language Processing methods such as Stemming and Concept Extraction to the raw data as the AI engine was executed.

Performance

Machine classification and text analytics require significant processing time. For a web application, system performance is a major challenge in the development of GeBIZ's BI platform. The team, after usability studies, decided on a maximum response time of 12 seconds per multi-year analysis and 100ms for analysis embedded in the workflow. To meet this performance requirement, classification and text analysis are performed natively within the database. The database and hardware architecture also has been significantly tuned to help overcome the performance problem. At present, tens of millions of items are now conceptually analysed across all of GeBIZ's transactions and results returned daily without significant waiting times.

Data Quality

GeBIZ portal is a system of many sub-systems built in phases over a period of a few years. As a transactional system, each component performs its work autonomously and these sub-systems contain silos of data representing islands of business and data rules, making it difficult to explicitly describe information across multiple business areas.

System changes due to policy and capability additions impose increased demands on the information schema. The information schema evolves over time and sometimes results in data redefinition and inconsistencies. Furthermore, government procurement is not an isolated process. GeBIZ receives data constantly from various external systems for processing. The data quality from these external systems is beyond GeBIZ's control. This combination of factors makes the reporting of historical data difficult.

Information Accessibility

Businesses change and evolve over time, often rapidly. To allow key decision makers insights into the market, they must be able to access relevant information immediately as and when they need it. This requirement called for a need to rapidly deploy cross-business reports or answer ad hoc queries. Before GMC was available to end users, ad hoc reports were generated manually, and that could take days or even weeks.

GE BIZ BI CAPABILITIES

Today, there exists a data warehouse where all aspects of GeBIZ transactions reside. Before entering the warehouse, data is cleansed of discrepancies and conformed into a single consolidated business schema. Data Marts representing business areas such as tenders or purchase orders provide reports and analyses. These Data Marts feed off the warehouse and



deliver a single version of the truth. The quality of data is monitored constantly and isolated for further processing if found to be questionable. To accomplish this, all business and data rules need to be explicitly identified, documented, encoded and stored in a metadata repository. With a metadata repository, the derivation of any field can be explicitly specified and rationalised.

Information Retrieval

Simple yet effective information retrieval and aggregation is necessary in GeBIZ to facilitate efficient and accountable decision making. All BI components are built with this premise in mind. Through a simple query field, different hierarchies of procurement information can be retrieved and aggregated from concepts to specific purchases across all agencies. Security is applied transparently depending on the user. The user's affiliated organisations and existing rights automatically determine the level of data he or she may view.

Demand Aggregation

DA is a means of facilitating efficient procurement. By consolidating frequent purchases into a contractual agreement, the government can exploit economies of scale to obtain favourable prices and reduce the transactional overhead of subsequent acquisitions of the same item by performing

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it upfront. However, demand has to be analysed before it can be aggregated. Yet as previously mentioned, transactions of government procurement are unstructured. It is difficult to classify millions of transactions into various taxonomies, and even harder to identify particular items in demand. The text analytic and classification approach described in this article was deployed to allow users to derive transaction trends at any hierarchy and resolution. In fact, any ad hoc queries that can be performed using the OLAP concept such as drilling, pivoting, dicing and aggregating can be applied to the unstructured content found in the databases of GeBIZ.

Enforcement

Even with effort spent on DA contracts, government users may not realise its existence and continue to make ad hoc purchases. This results in contract leakages. The BI platform can facilitate contract leakage detection by:

- Allowing procurement experts to quickly review all kinds of ad hoc purchases
- Check for patterns of contract leakages such as the referencing of a period contract
- Performing brute force searching of all transactions across contracts

Multi-faceted Analysis

BI can offer many unique and different perspectives to its users. The BI solution of GeBIZ provides a multi-level analysis in the form of scoreboards, dashboards and alerts. Through scoreboards which typically measure KPIs, top-level management can view the procurement performance of their organisation at a glance. These KPIs are colour-coded to depict the various aspects of procurement health they measure.

In addition to scoreboards, dashboards are also available to show aspects such as current transaction status and period contract

utilisation to aid operational users. Users can monitor their dashboards and react to events accordingly. Even with detailed reporting, information may not be timely enough for specific operational requirements. To that end, an alerting ability integrated with every BI capability was deployed. This alerting capability can automatically email, page, broadcast or push information to its users when a condition e.g. a purchase is met.

Automation

Lastly, a recurring theme of many BI mission statements is that 'the right Information should be pushed at the right time to the right person'. In GeBIZ's BI solution, this capability is called 'GeBIZ Delivers' and it is a scheduling engine. Reports can be sent at pre-determined intervals to dynamically determined individuals based on various customisable criteria. Furthermore, the system is able to trigger procurement workflow processes and execute user-defined scripts to perform tasks on behalf of its users.

BI MATURITY

In 2007, on the 50th anniversary of Hans Peter Luhn's definition, The Data Warehousing Institute (TDWI, 2007) published its annual Benchmark Report. With a scale analogous to human maturity (Infant, Child, Teenager, Adult, Sage), it is reported that "two-thirds of organisations are Teenagers of the TDWI BI Maturity Model". Of the remainder, 20% were in the Child stage, 15% in the Adult stage, and Sages were almost non-existent at 0.6%. Furthermore, the report also stated that "there is a correlation between the age of a BI programme and its maturity. More than two-thirds (68%) of organisations that score in the Child stage have BI programmes that are less than two and a half years old, whereas 78% of Adult-stage BI programmes have existed for more than five years. Just as in human development, maturity comes with age". The process of BI development never ends. BI must react in cadence with its host business and the nature of any business always changes. To that

end, continuous reactive and predictive development efforts are required for any BI project team.

Acknowledging the immense challenges and uncertainty involved in the development of a BI solution, the project team adopted the philosophy that a BI solution is not a one-off project. When harnessed correctly, a BI situation becomes a cornerstone of its host system. Hence, BI must evolve together with the system and be ready to support new decisions in a constantly changing environment.

CONCLUSION

Incorporating BI in GeBIZ is a complex and challenging undertaking, but the returns on investment are enormous. The introduction of this BI platform in GeBIZ will result in a capability increase for government procurement agencies and elevate Singapore government procurement to a higher paradigm of intelligent sourcing and purchasing. This will raise government procurement to a strategic level and bring about more collaboration and partnership among government agencies and the industry. A BI-enabled GeBIZ will not only increase the efficiency of government agencies but also improve the effectiveness of government procurement, resulting in huge cost savings for the public sector as a whole.

REFERENCES

Eckerson, W. (2007). 2007 The Data Warehousing Institute BI Benchmark report.

Luhn H. P. (October 1958). A Business Intelligence System (PDF). IBM Journal. Retrieved on 10 July 2008 from <http://www.research.ibm.com/journal/rd/024/ibmrd0204H.pdf>

Power D. J. A Brief History of Decision Support Systems, version 4.0. DSSResources.COM. Retrieved on 10 July 2008 from <http://dssresources.com/history/dsshistory.html>

BIOGRAPHY



Carol Lo S Chia is the Assistant Director of the Electronic Business Centre. Besides managing the development and operation of the Government Electronic Business (GeBIZ) Portal, she oversees the development and implementation of the Electronic Procurement System for the Ministry of Defence (MINDEF) and the Singapore Armed Forces. Carol spearheaded the development of the MINDEF Internet Procurement System in 1998 and also implemented a few large-scale IT systems related to Procurement and Cataloguing before initiating the development and implementation of the GeBIZ portal for the public sector. Graduating with a Bachelor degree in Physics (First Class Honours) from the National University of Singapore, she went on to obtain a Master of Science in System Analysis and Design from the London School of Economics and Political Science, University of London in 1983 under the Engineering and Scientific Professional Training Award.

Leo Chen Hong is an Engineer (Enterprise IT) and was previously part of the team that developed and operates GeBIZ InSIGHT and GeBIZ Management Console. He had been involved in the back-end development and front-line operations of many aspects of business intelligence for government procurement. These included requirement analysis, data modelling and profiling, Extraction Transformation Loading development, dashboard and scorecard design as well as end-user application development and support. Chen Hong holds a Bachelor degree in Linguistics and Computer Science from the University of Michigan.

