WEB KNOWLEDGE MANAGEMENT FOR SMALL AND MEDIUM-SIZE ENTERPRISES

WebTour: a case study from the tourism sector

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Abstract: The current enterprise world has become global and complex. Knowledge management is a key to have a competitive advantage as it allows detecting in advance customer trends and market evolution. While knowledge management systems are usually unaffordable for small or even medium-size enterprises, a tool to be shared between them is a more realistic solution. The system, based on client/server architecture with a web interface, is able to provide top Information Technology (IT) solutions for a low cost so that small and medium business can also use these systems to acquire competitive advantage. We have developed a solution for a IT enterprise providing an on-line reservation system for small tourist lodgings and travel agencies. It consists of a Data Warehouse (DW) and a Decision Support System (DSS) which is currently being offered as a value-added service for providers and customers. The DSS is also used by the Acquisition Component of a Knowledge Management System (KMS).

1 INTRODUCTION

Most of the Small and Medium-size Enterprises (SMEs) cannot afford sophisticated information systems for strategic decision making process. Even the data cannot be organised in order to easily accomplish queries from the point of view of business executives. Therefore, DW, DSS and KBS are not yet common systems in many SMEs. The lack of strategic resources is currently one of the main causes for these companies to loose competitive advantage. Even worse, for very dynamic business, large enterprises can take over SMEs just because of the difference in the development of software tools for strategical purpose.

To face this problem, SMEs have basically two solutions: (1) to create strategic alliances so that costs for these systems to be developed can be shared and (2) to choose a provider able to offer knowledge management as a value-added service. Both solutions are now more than never before technically feasible. By using a web-enabling implementation, they are also more affordable, and easy to use.

In this work we introduce a practical solution for small or medium-size business to share knowledge management software, so that they can compete with larger enterprises. These systems, which have been called Web Knowledge Based System (KBS) or Web KMS (Bartenstein et al., 2003), are based on a DW and they are able to provide knowledge management by using DSS

and/or data mining tools through a client/server architecture with a web interface. Opposite to just data warehousing, which reduces the creation of massive data, a new step in these systems includes development of tools for these data to be interpreted and the opportunity for the companies to create value from their intangible assets. Information from several sources, such as data bases, IT web pages, e-business, e-commerce, on-line transactions, etc. is transformed into knowledge to take full advantage of the current huge amounts of data.

The solution that we present has already been implemented and it is actually being offered to more than 400 tourist SMEs, as a value-added service provided by ViveGranada S.L.L., an on-line reservation center for small tourist lodgings in Spain. Other enterprises belonging to completely different business sectors can make use of these systems, either for IT enterprises to provide as a value-added service to their customer SME or for any SME to adopt as a solution to be shared among other enterprises in the same branch. The global connectivity provided by a web-based system allows SMEs to establish strategic alliances with similar enterprises that can reside in different countries and have different markets, so that they are not competitors. As an example belonging to the tourism sector, SMEs providing lodging, as vacation rentals, rural houses or small hotels can share costs if they share not only an on-line reservation system but a web KMS. If they provide lodgings from different geographical points, they are not competitors but strategic partners.

This paper is organized as follows. Section 2 contains an introduction to web KMSs. In Section 3 we describe in detail WebTour, the web KMS that we have proposed to ViveGranada and that we have already implemented, as a case study of how these systems can be used for SMEs to achieve competitive advantage. Moreover, a description of the main subsystems to be used by SMEs, the reservation Data Mart (DM) and the DSS, is provided. Finally, the conclusions and future work are given in Section 4.

2 WEB KNOWLEDGE MANAGEMENT

A Web Knowledge Management System refers to the Knowledge Management that is accomplished by using a client/server architecture and a web interface, so that access from every Internet-access point, no matter the operative system or the web browser, is possible without software installation.

2.1 Knowledge Management

Knowledge management has different meanings depending on the field. From an IT point of view, the one in this paper, it refers to more advanced systems than standard information systems able to assist the enterprises to acquire knowledge from information. In contrast, from the point of view of the social and financial sciences, knowledge management refers primarily to assessing, changing and improving human individual skills and/or behaviour (Sveiby, 2001).

Although knowledge management is a very wide concept, all KMSs and the more specific Expert Systems (Castillo et. al, 1997) have in common to be made up of at least three components: the Knowledge Base, in which data and rules are stored, an Inference Mechanism, in order for the system to produce new knowledge and an Acquisition Component, to feed up the Knowledge Base.

In order to build reusable information systems, able to share data and components, they can be related in a layer architecture, in which a KMS will be in the external layer while a Data Base Management System (DBMS) will be in the core. On top of the DBMS, in the second layer, a DW models the data to corporate standard and fulfils the reporting requirements or demands of decision makers, ensuring that data to be used are clean and consistent. The capabilities of DW to provide a large amount of relevant and pre-calculated information, together with the fact that Internet has grown to become a major media for information diffusion in any organization can have positive impacts on decision performance. In the third layer we can have models and analytical tools specifically designed in order to assist in decision making, so that we will have a DSS. A DSS is a computer program application that analyses business data and presents it so that users can make business decisions by using knowledge automatically generated from it. Typical information that a decision support application might gather and present would be comparative sales figures between one week and the next, projected revenue figures based on new product sales assumptions and the consequences of different decision alternatives, given past

experience in a context that is described. A DSS may present information graphically.

In the fourth layer there will be a Knowledge Base, an Acquisition Component, used to add knowledge to a Knowledge Basefrom the DSS and an Inference Mechanism used in order to obtain new knowledge upon the Knowledge Base, all of them making up the KMS. The Acquisition Component must be able to incorporate information to the Knowledge Base each time an executive makes use of the stored information for decision making.

2.2 Web enabling application

These applications are based on a client/server architecture that describes two processes. The first is the proactive client that sends requests to the server. The server process is the reactive portion of the system that does nothing but processes requests from client. As we want a web-enabled KMS, we would still have a client/server application. The Internet is just a specific type of client/server implementation.

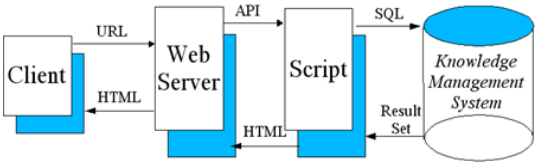

Figure 1. Web interface for a KMS.

Figure 1shows the web interface for a KMS. The browser is the presentation layer of the application. Through it the user communicates with the Web server. Since the Web server directly communicates with the browser, the client system is invisible to the application. Any client capable of supporting a browser can access any Web-enabled client. The strategist would click on the report icon that causes the browser to send a URL (Uniform Resource Locator) to the DW's Web server. The URL contains the reference to a Common Gateway Interface (CGI) to a script or computer program able to access the data. Upon receiving the result, the web server converts the report into HTML, which is passed to the browser on the client.

By web-enabling the KBS we shift the processing from the client to the server. The client simply runs the browser. The processing of the data is done back on the server. Also, the client's actual hardware and software are invisible to the application scripts.

Shifting the processing from the client to the server has other important benefits. Most of them translate into cost reduction, as a reduced administration and maintenance or an easy distribution of data. Others regard with the willingness of a user to use specific software, as the intuitive Graphical User Interface (GUI) that has the web.

3 WEBTOUR: A WEB KMS FOR TOURISM ENTERPRISES

We provide a case study of an IT company focused on the tourist sector. Some specific solutions for this sector have been proposed in order to integrate different information systems (Kirkgöze & Tjoa, 1998) or to use a DW to help in the decision making process (Haller et al., 2000). However, integral solutions for this sector seem to be less frequent. The enterprise, ViveGranada S.L.L., has developed an on-line availability and reservation system of lodgings owned by SMEs. Their providers, about 200 SMEs, benefit of an e-commerce system for a low cost that can be used by travel agencies all over the world or by end users. They provide also, through an extranet, other e-business services, including account and invoice management, electronic fund transfer and a query system to obtain information about reservations and payments.

WebTour is a web KMS made up of several subsystems interconnected as it is shown in Figure 2 and described in this section. ViveGranada offers to their providers, the owners of tourist lodgings, access to one of the DMs already implemented, a DM focused on the reservation systems and to the DSS. This is offered as a value-added service. Other DMs, as human resources, suppliers and Customer Relationship Management (CRM) are planned to be developed in the next phase.

3.1 The DW

The advantages of using DW are a better knowledge of the business, the possibility of improving the service to customers, a better awareness of the business risks, and an improvement of the business processes, being able to make more tailor-made products and services.

Inmon (2002) defined a DW as "a subject-oriented, integrated, time-variant, non-volatile collection of data in support of management's decision-making process." A DW is a database that stores a copy of operational data whose structure is optimized for query and analysis. By definition, the scope of a DW is the entire enterprise. Related to a more reduced scope, a DM has to be used, which is a highly focused DW and its scope is a single department or subject area. The DW and DMs are usually implemented using relational databases (Hammer et al., 1995), (Harinarayan et al., 1996) defining multidimensional structures.

In a generic architecture of a DW (Chaudhuri & Dayal, 1997), data sources include existing operational databases and flat files (i.e., spreadsheets or text files) in combination with external databases. The data are extracted from the sources and then loaded into the DW using various data loaders and ETL (Extract, Transform and Load) tools (Araque & Samos, 2003). The DW is then used to populate the various subject (or process) oriented DMs and On-Line Analytical Processing (OLAP) servers. DMs are subsets of a DW categorized according to functional areas depending on the domain (problem area being addressed) and OLAP servers are software tools that help a user to prepare data for analysis, query processing, reporting and data mining. The entire DW then forms an integrated system that can support various reporting and analysis requirements of the decision-making function.

There are two approaches to build a DW. In the first approach, stand-alone DMs assigned to individual business units or processes are developed and later integrated into an enterprise-wide DW. In the second approach, a complete DW made up of distributed DMs is built. These DMs are populated with data either at the time of initial development or at different stages depending on the availability of time and resources (Inmon, 2002), (Kimball & Ross, 2002). The first approach is adopted by WebTour as it fits with the scope of this research. However, in the first phase of WebTour, already concluded, the reservation DM has been the only one that was developed.

The DW is built in MySQL, a relational database with a web-based interface. The database, different from the operational databases of ViveGranada, is composed of 25 tables.

The DW extracts information on a daily basis from two operational databases of ViveGranada, one implemented with MySQL and the other being implemented by a proprietary system. Extraction is automatically done.

The main functionality of a Web-enabled DW allows specialists to access specific data as a report after querying the DW. Following the star schema of the reservation DM, there are two types of tables in a DM: the fact table and a set of dimension tables.

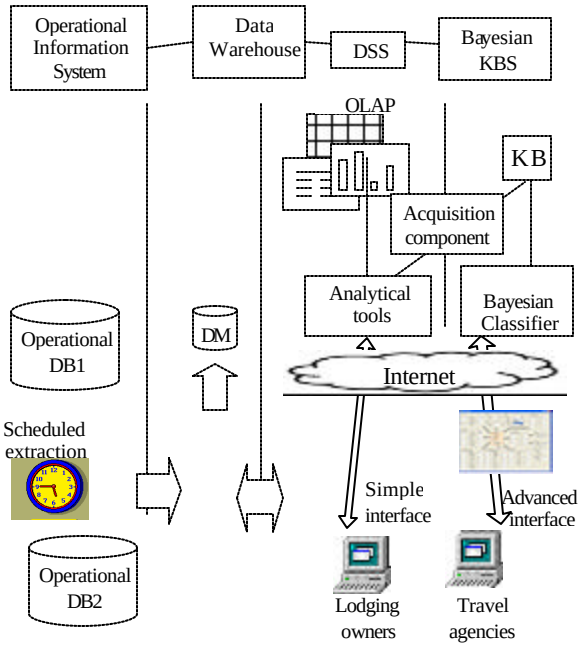

Figure 2. Architecture of WebTour.

The DM design essentially consists of three steps as follows (Kimball & Ross, 2002):

1. Identifying facts and dimensions. Facts represent quantitative (or factual) data about a business entity, while dimensions contain descriptive data that reflect the dimensions of that entity.
2. Designing fact and dimension tables. The dimension tables are connected with the fact table by foreign keys. As a result, a fact table contains facts and foreign keys to the dimension tables.
3. Designing DM schemas. The schema is a database design containing the logic and showing relationships between the data organized in different tables (or relations). A DM is composed of a central fact table and a set of surrounding dimension tables.

The fact table is the reservation table, so that each fact in this DM corresponds to a lodging reservation. The application web interface includes

the possibility to query directly these tables to see their contents. Also we can create and destroy grouping conditions that define new entries. Grouping conditions are stored in a GP-table (there is one for each dimension table) which plays an important role in the final report. The user must specify a field of that table, a condition to be imposed on the field and the name of the grouping. As an example, the form to create a group can be filled in order to create a group for those lodgings that have swimming pool. The name of the new group could be WithSwimmingPool and the group condition is imposed on the Boolean field Swimming Pool of dimension table Lodging.

The OLAP server is accessed by using scripts. In a report only dimension tables and its associated GP-tables can be used. Using a form, the user decides which of them to choose. With a PHP script, the HTML page will show a field list for the previous tables so that the user can select the fields to include in the report as well as the grouping condition.

3.2 The DSS and KMS

The use of new technology, such as Data Warehousing, Decision Support Systems, Data Mining, data integration, etc., has been proposed previously in many fields, not only in tourism. Thus, some applications of these technologies are, for example: the use of DWs and Data Mining as a basis for strategic decision in tourism (Kirkgöze & Tjoa, 1998); the integration of heterogeneous tourist information data sources using a three-tier architecture, consisting of a Data Source Adapter Layer, a Mediation Layer and a Client Layer (Haller et al., 2000); and the application of DW and Decision Support System in Soaring site recommendation (Araque et al., 2006).

The purpose of the DSS is to enable analysts to easily extract information. The system has to provide a way to analyse data depending on the user profile. For experienced users with a clear idea of the contents of the DM, the system allows them to develop 'ad hoc' parametric queries. In contrast, for novel users, the system provides a set of high-interest predefined queries. There are also other criteria affecting the type of queries that the system allows. One of them regard with costs and it includes mainly computational time —the allowable time to run a query— and space —the total number of information that can be returned from a query— (Chau et al., 2002).

These two criteria have been taken into account by the DSS of WebTour. While no restriction is imposed to Chief Executive Officer (CEO) and Chief Information Officer (CIO) of ViveGranada, for all other staff and the providers only predefined queries to the DSS with a limited quantity of time and information to be displayed are allowed.

Figure 3 shows the DSS form to develop parametric queries. A graphical report given by the WebTour DSS is shown in Figure 4. It corresponds to a query about the average number of individual per reservation, considering the origin country of the travel agency that made the reservation and the location (province) of the tourist lodging.

In addition, the user interface for the DSS of WebTour has been designed to provide end users with a comfortable and easy to use environment. One of the most important attractions of this interface is its ability to make dynamically queries, to aggregate and analyse data, and to present and visualise results.

Once a DSS returns a report to a query, the Acquisition Component of the KMS receives also the information and the executive must select the output variable representing the decision making process s/he is working on. The KBS is a probabilistic one (Castillo et. al, 1997) as it uses a Bayesian network instead of rules in the Knowledge Base. For each type of decision, i.e. for each class or output variable, a new Bayesian classifier will be created. The Inference Mechanism will allow the user to decide if a feature selection mechanism is required and to choose among different architectures for Bayesian classifiers. Accuracy in knowledge acquisition has been probed for different Bayesian classifiers in order to decide relationships between Operation Strategy and Flexibility in engineering consulting firms (Abad-Grau & Arias-Aranda, 2006).

4. CONCLUSIONS AND FUTURE WORK

We have proposed the use of shared web KMS as an affordable way to provide knowledge management for SMEs, by means of strategic alliances or as a value-added service provided by IT providers.

As future work, we plan to use other data mining engines in order for the Acquisition Component to directly obtain information from the DW. In addition, we plan to investigate methods to

incorporate more sources of information into a DW as XML or other semi-structured sources. While it is getting more common to find web sites which output information from their databases in XML code for consumption by a variety of agents or applications, to read XML documents and to integrate that information into databases is not a trivial task.

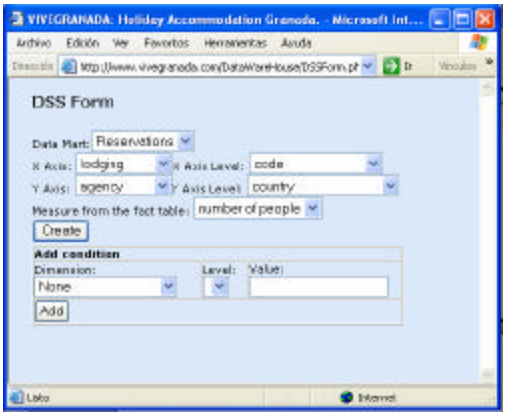

Figure 3. A DSS form for a parametric query of the KMS WebTour.

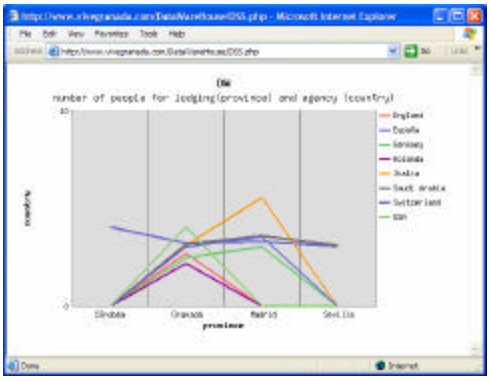

Figure 4. Plot returned by the DSS system for the parametric query in Figure 3.

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