PRACE NAUKOWE
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RESEARCH PAPERS
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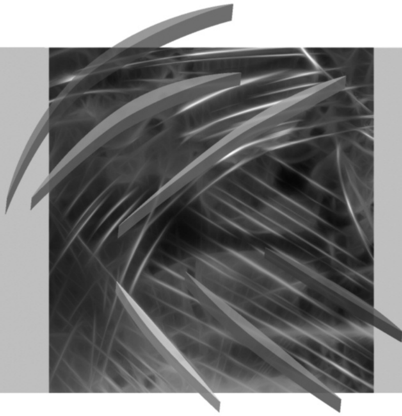
206

Advanced Information Technologies for Management – AITM 2011

Intelligent Technologies and Applications



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Publishing House of Wrocław University of Economics
Wrocław 2011

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www.wydawnictwo.ue.wroc.pl

ISSN 1899-3192
ISBN 978-83-7695-182-9

The original version: printed
Printing: Printing House TOTEM

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PRACE NAUKOWE UNIWERSYTETU EKONOMICZNEGO WE WROCŁAWIU nr 206
RESEARCH PAPERS OF WROCŁAW UNIVERSITY OF ECONOMICS

Advanced Information Technologies for Management – AITM 2011 ISSN 1899-3192
Intelligent Technologies and Applications

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A DECISION SUPPORT SYSTEM BASED ON THE DDMCC PARADIGM FOR STRATEGIC MANAGEMENT OF CAPITAL GROUPS

Abstract: The aim of the paper is to present the findings and practical outcomes of research on DSS capable of supporting the consolidations process in management of capital groups. The article presents an original approach to both the design and processing of distributed data acquisition system designed for strategic management, as well as an original approach to the use of such solutions to support strategic decisions for capital groups. The final section of the paper describes the implementation of the financial consolidation support system in capital groups, which is the most recent application of the concept presented.

Keywords: DSS, capital groups, consolidation process, Data-Dialog-Modeling-Communication-Creativity paradigm, hybrid architecture.

1. Introduction

The classic approach to the consolidation of financial reporting focuses on serving the financial statements and stock market reports. The growing importance of groups in shaping the competitive position of enterprises, especially on international markets, fundamentally changes the expectations for the information obtaining in the process of financial consolidation. We have observed a rapid growth of demand for information in support of strategic decision-making processes related primarily to the increase in market value of the group [Wartini-Twardowska, Twardowski 2010]. An important source of such information are the effects of simulations of consolidated financial results capital groups. While multi-dimensional simulations in the form of financial projections and sensitivity analysis are well known to the manage-

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ment of capital groups, the simulation of results depending on the structure of ownership relations in the group is a quite new approach. So, the purpose of this simulation is to observe the consolidated financial results of the parent company in relation to the structure of ownership relations of subsidiaries and associates, and accepted methods of consolidation. The final assessment of consolidated results is performed, in many aspects among others from the point of view of the group profitability, liquidity or long-term debt structure [Wartini-Twardowska, Twardowski 2009]. As a result, the information was obtained to support the improvement of the structure of the group within the adopted strategy of the parent company.

Making such decisions is impossible without the use of modern data processing technology and, based on expertise, models of consolidation. The article presents an original approach to both the design of distributed data acquisition and processing systems (based on Data-Dialog-Modeling-Communication-Creativity paradigm), as well as an original approach to the use of such solutions to support strategic decisions in capital groups. On the one hand, we apply multi-variant simulation of consolidated financial results of the group, and on the other, we use opportunities of processing, viewing and presenting of the information offered by Business Intelligence Systems. The proposed system architecture has been developed in the company CONSORG SA for six years. Implementation of this solution in Polish capital groups allows for the improvement of solution architecture as well as of implementation methodology. At the same time, the performed implementations create the basis of theoretical considerations verification carried out in cooperation with research units.

2. The basic process (problem definition)

The basic process of consolidation, under the proposed approach, includes ten major phases (see Figure 1). Control of the task within each phase is supervised by "work flow module", which is responsible for monitoring of the progress of the process.

The consolidation of entities (subsidiaries and associates) forming the current and future capital group (phase 2) is defined as a part of the defined task set. The collection must consist of at least a set of companies (subsidiaries and associates) to be consolidated according to the rules set by the IAS and IFRS (s1, s2 s3 and s5, s6). Then User (parent of the entity), on the basis of a predefined set of firms, creates subsets of the capital group: G1, G2 and/or G3 (see Figure 2).

These subgroups may include companies which are not covered by the statutory obligation of consolidation. They are created only in order to observe financial results of such subgroups and assess their impact on the outcome of parent of the entity. Another milestone in the process is to support users in balancing intercompany transactions (of course the previously defined subgroups). To be effective, such a reconciliation must be carried out practically in real time. All intercompany transactions should be balanced by the subsidiaries, and during the process the parent acts only as an observer and arbitrator. The key role in coordinating the reconciliation

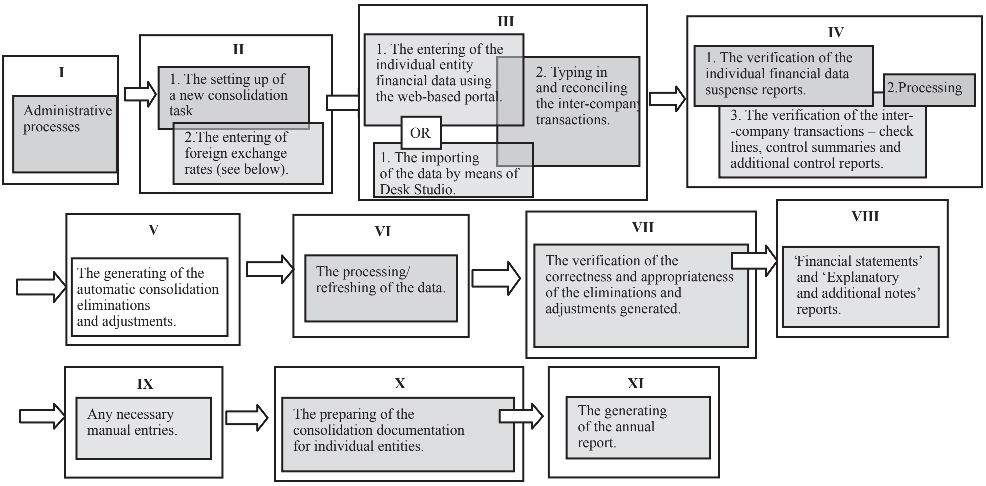
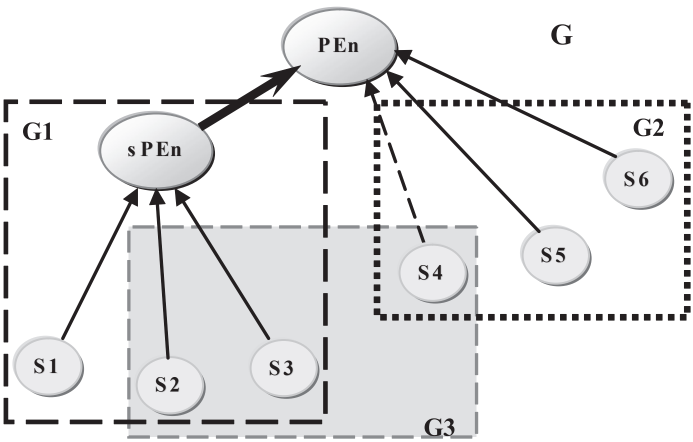


Figure 1. The basic process of consolidation

Source: CONSORG SA.



PEn – parent of entity, sPEn – parent of entity of subgroup, G – multi level capital group (consolidated according to the rules set by the IAS and IFRS), G1 – subgroup, G2, G3 – the subsets created especially for management control financials of capital group

Figure 2. Select the entities that will be consolidated in a given period

process of the intercompany transactions is played by a workflow module. The primary function of the workflow module, at this stage, is creating news on an ongoing basis for all participants in the process about progress of mutual balancing of intragroup transactions. Such information shall be provided through the so-called "mechanism of control lines" on the screen of each user. Special reports available to the parent of the entities allow the analysis of all intra-group transactions and diagnosing the causes of detected discrepancies. This phase is terminated by the parent by closing access to editing of data for subsidiaries and associates. The next important step in the process of consolidating the financial results of the group is the automatic eliminations of intercompany transactions and reclassifications. Eliminations and reclassifications are based on the "eliminations model" of Consorg/Dominium/EPM system based on a set of deterministic rules that contain both procedural and declarative knowledge. As a result of using the eliminations model, we can obtain all consolidated financial statements, pre-defined groups of companies. At the same time, the parent receives a set of diagnostic reports for monitoring the financial condition in the various capital subgroups and across the whole group. Performing simulation of the type: "what if you change the structure of the capital group" does not require activation, described earlier, of phases of arrangements intercompany transactions (of course, only if we do not intend to increase the capital group structure by adding new subsidiaries).

3. The system architecture

System design is based on the concept of model consisting of five components: data – dialogue – models – communication and creativity (DDMCC). The DDMCC model is an extension of the Sprague-Carlson classical concept of the DSS architecture [Stanek 1999; Stanek, Sroka 2001].[1]

Data component. This component's architecture is founded on an analytical platform making up an integrated framework of application development which incorporates: relational databases, multi dimension databases and OLAP technology, fuzzy logic, expert systems and knowledge bases (including deep and shallow knowledge). Data acquisition is a four-stage process: (1) importing data from transactional systems into the data warehouse, (2) transforming data into multidimensional OLAP cubes, (3) using the data in report generation by analytical applications, and finally (4) publishing and distributing the results (documents, EIP, mobile devices). Generally, the data collection process can be divided into four main areas (layers) by indicating the most important task performed at each stage [Kostrubała, Stolecki, Twardowski 2003]: (1) Information Suppliers layer – contains all the data acquisition systems and applications, (2) Storage and Transformation layer – responsible for storage of the imported source data and for transforming it into the form required by the analytical applications, (3) Information Sharing And Reporting layer

[1] The data-dialog-modeling paradigm proposed by Sprague and Carlson [Sprague, Carlson 1982], and the DSS architectures that have sprung up from that seminal concept, provide a widely accepted reference framework for most contemporary DSS designers. Nevertheless, the new information era seems to call for modifications of the Sprague-Carlson triad to make it better suit the evolving needs of designers and their customers. This is reflected in current DSS classifications which differentiate between systems oriented on data, dialog, modeling, knowledge, communication or, just recently, creativity [Stanek, Sroka, Twardowski 2006].

– the reporting components, and (4) Information Consumer layer – this area contains tools, applications and devices utilized by end users (dedicated "thick" BI packages, e.g., Consorg Desk Studio or IBM/Cognos/TM1, Office packages, e.g., Microsoft Office, Web applications, Web services, portals (EIP), Mobile devices: pocket PCs, palmtops).

Dialog and Communication components. Within our implementations of the proposed architecture, the dialog component takes the form of an analytical desktop. The analytical desktop, implemented as an interface agent operating in an intranet or Internet environment, is the preferred interface solution allowing access to analysis findings and to reports generated. The interface agent and/or expert system may play a central role in the process of communication with the user.

The expert system represents an important element of the component's architecture, performing three fundamental functions [Kostrubała, Stolecki, Twardowski 2005]: (1) diagnosis – using a set of observable symptoms to determine the current state of the enterprise (as well as identifying weak signals e.g. from the environment), (2) construction – creating detailed user reports based on the diagnosis performed. The reports are customized to the current user's needs, where critical information is presented in the form of brief conclusions, while additional explanation is provided in the form of tables and presentation graphics, (3) control – controlling the application by monitoring the user's activities and triggering appropriate actions depending on the current context of analysis (e.g. customizing report generation, executing data transformation scripts).

As a part of objective finding, the so called key performance indicators (KPI) are sought, which are the facts constituting the original causes (sources) of the current state of the object being diagnosed – i.e. the financial condition of the capital groups. It is assumed that discovering these facts will provide the basis on which the actual diagnostic problem can be formulated. The fact finding process employs data mining technologies to query the multi-dimensional OLAP data bases. The classical ad hoc drill-down search is supported by an expert system. The expert system's inference process governs the drilling toward the discovery of relevant facts. This means that the formulation of a drill-down query depends on the conclusion produced by the expert system. The query result then fires another sequence of rules which will trigger a further drill-down query. The process terminates in case the expert system is unable to generate a conclusion and, consequently, activate another query. The objective finding should take place through discovering the underlying cause-and-effect chains among the increasingly more detailed information sets delivered in the query reports.

Model (modeling) component. The modeling process aims to support the user (for example, a financial analyst) in detecting the symptoms of potential threats – weaknesses of the strategy being pursued. The main components involved in this process are: OLAP databases, analytical business models, rule based fuzzy expert systems, and procedural and declarative knowledge bases.

Each of the leading artificial intelligence technologies exhibits some strengths or weaknesses depending on the application context [Medsker 1998]. Literature supplies many examples of successful applications based on an artificial intelligence technology hybridization paradigm [Goonatilake, Khebbal 1995]. In addition, hybridization may be regarded from the viewpoint of the relationships between the database platform and the data processing technologies used. This approach substantially extends the area in which to search for component combinations to apply in addressing a problem, bringing us closer to the selection of the best solution. The power of OLAP technology to help identify cause-and-effect chains by manipulating quantitative data means that it can provide effective support for strategic processes in organizations. The most promising business results are achieved through its integration with MRP/ERP class systems [Stanek, Sroka, Twardowski 2004]. On the other hand, some artificial intelligence components, such as expert or fuzzy logic systems, are capable of efficiently handling qualitative (symbolic) data. It seems that combining the strengths of OLAP technology with artificial intelligence components capable of supporting symbolic data processing will make it possible to build a technology platform which can effectively handle decision processes at the strategic level. Efficient application of artificial intelligence therefore involves the use of an appropriate combination of leading-edge technologies to produce a synergy effect. The authors' experience has allowed them to tentatively validate the effectiveness of particular artificial intelligence component applications in process modeling. The intelligent hybrid objects which have emerged from the synthesis are linked to database platforms.

Creativity component. Within the proposed approach, solutions to diagnostic problems are searched by generating and validating different sets of hypotheses (scenarios). The validation process relies on the monitoring of a range of the so called risk signals, i.e., key performance indicators identified for each area being examined. Hypotheses, taking the form of likely decision-making scenarios, are generated by the expert system and derived from the financial analyst's interactive queries to the multi-dimensional OLAP bases and knowledge bases [Stanek, Sroka, Twardowski 2007]. As a result, a given set of hypotheses is broken down into opportunities and threats, with a weight attached to each of them indicating its relevance. An opportunities and threats analysis, which is subsequently performed within each area of the enterprises' activity, focuses our attention on the most significant opportunities and threats, reducing the set of hypotheses to an extent where we are left with just those most promising ones. An assumption has been made that, as T. Proctor [1999] has it, "the sole realization that there exist different views on the same subject may give rise to an exchange of opinion and elicit new ideas". Therefore, the ensuing solution finding procedure encompasses all combinations of opportunities and threats that have been recognized as significant. The procedure aims to reconstruct the perception of the issue under consideration and then use the opportunities and threats combinations to develop a viable solution (ideas).

Each of the conclusions is backed up with the underlying sequence of the expert system's knowledge base rules that have been fired. In case contradictions are detected, they will be typically attributable to varying interpretations of facts reflecting the diverse perceptions of the knowledge providers who have fed the expert system. In investigating the contradictions (by tracing the explanations) the user should be encouraged to formulate and test a number of hypotheses. There are two types of potential contradictions that will call for a critical review of the diagnostic problem: one of them occurs when the expert system returns varying conclusions for the same factual body, while the other arises when identical conclusions are coupled with different explanations. Within the proposed approach the issue of keeping the knowledge stored in the expert system up to date does not figure much, as new knowledge extends, or supplements, the existing resource rather than replaces any portion of it, in this way opening up a new perspective on the problem. The analytical phase thus finally produces an open set of tentative (and sometimes incompatible) solutions to the problem.

At the evaluation phase, the solutions are ranked against the objectives. The basic evaluation criteria laid down by P. Drucker are used: risk, effort, time and resources. Special emphasis is placed on the possibility to test the idea in "a safe environment" before the final evaluation is made. To this end, support tools have been implemented, such a: simulation models, sensitivity analysis and business simulators and/or strategic decision making games [Stanek et al. 2008]. The best solutions are expected to make up a coherent scenario that fully elucidates the problem. These solutions are included into a separate knowledge base (known cases base), which is regarded as a complementary knowledge resource for use in creative solution finding with future diagnostic problems.

4. Business architecture and implementations

The process of preparing consolidated financial statements may be sub-divided into two sub-processes: (1) the sub-process of gathering the individual entity financial data, and (2) the sub-process of aggregating the data, posting the consolidation eliminations and adjustments and preparing the final set of consolidated accounts. To support these two sub-processes, our IT solution consists of two different tools:

– a web-based portal designed for all the entities the group is comprised of and allowing the entities to enter, reconcile and agree their individual financial data,
– a desktop application designed for the parent entity enabling it to aggregate the data, verify its correctness, generate the automatic consolidation eliminations and adjustments and print off the final set of accounts.

Consorg Dominium EPM system based on DDMCC model, can operate on two system architectures – IBM/Cognos/TM1 or Microsoft/SQL Server/Analysis Services (see Figure 3).

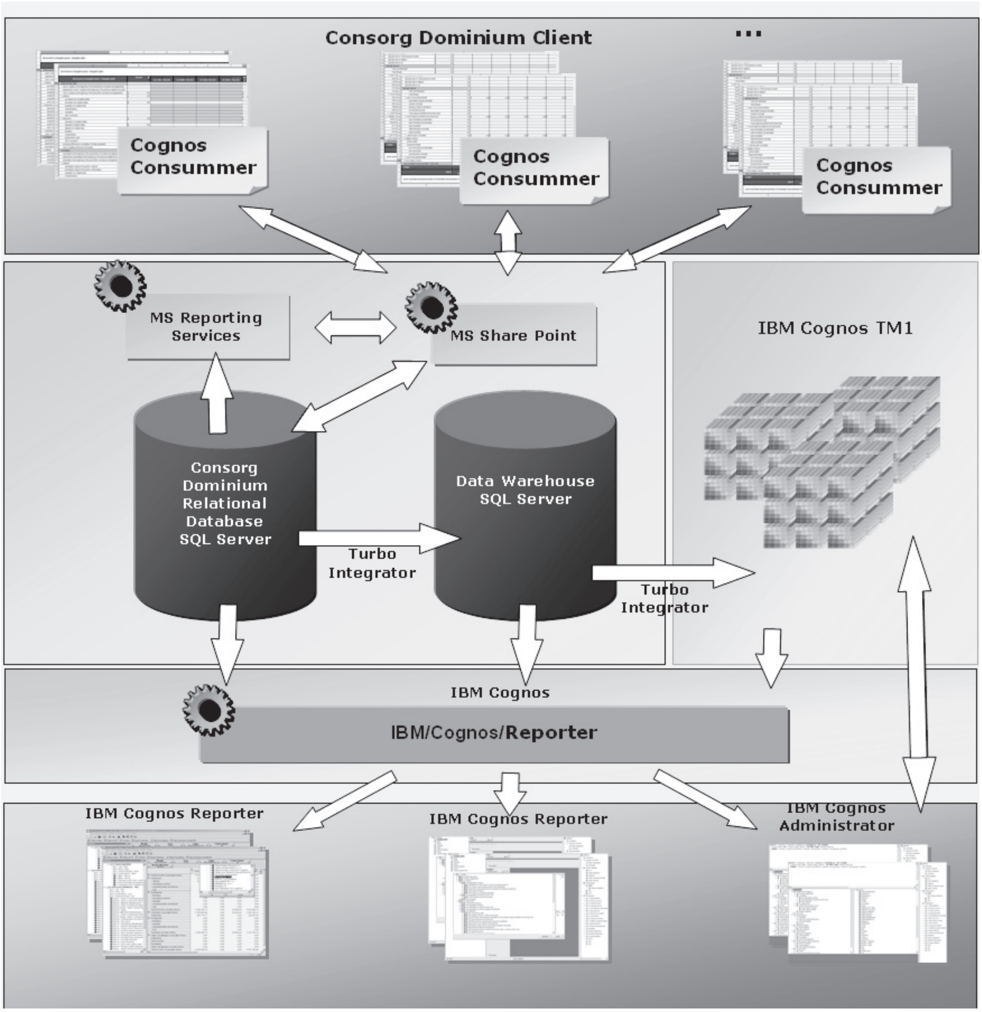


Figure 3. Business architecture model based on IBM/Cognos/TM1 and Consorg/Dominium

Source: CONSORG SA.

Consorg Dominium Client is a predefined data entry templates used as a data input and verification method. Consorg Dominium Client supports manual data entry, MS Excel sheets data import or automatic database or files (optional) loading. Data verification process is based on online check-lines mechanism. Cognos Consummer is an IBM/Cognos client for predefined reports supporting advanced business logic

Table 1. An overview of implementations of the 5 main projects of the DDMCC model architecture used to consolidation of financial statements for external reporting and internal management purposes

Company (capital group)	DDMCC Componets
Katowicki Holding Węglowy SA (KHW) One-layer capital group, 8 subsidiaries 5 primary users, 25 other users (project in progress)	• Data – relational and multidimensional databases (SQL Server, IBM/TM1) • Dialog – analytical desktop – primary users IBM/Cognos, others IBM/Cognos/consumer, Consorg/Dominium/forms • Models – (1) Consolidation of financial statements for external reporting - PAS (Polish Accounting Standards) and IFRS. (2) Consolidation of financial statements for internal management purposes – simulations and financial monitoring using expert systems reports • Communications – based on the work flow module responsible for monitoring the progress of the process • Creativity – not activated yet
Paccor SA/Veriplast SA/and other international sub-groups Multi-layer capital group, 170 subsidiaries 5 primary users, 250 other users (project in progress)	• Data – relational and multidimensional databases – MS SQL Server, MS Analysis Services • Dialog – analytical desktop, Consorg/Desk/Studio for primary users and Consorg/Web/Studio for other users • Models – (1) Consolidation of financial statements for management purposes (IFRS). (2) Multi-dimensional simulations of capital sub-groups structure and financial monitoring and budgeting • Communications – based on the work flow module responsible for monitoring the progress of the process • Creativity – not activated yet
Cersanit SA Multi-layer capital group, 40 subsidiaries (including a Russia-based sub-group), 10 primary users, 25 other users the parent quoted on the Warsaw Stock Exchange Implementation period: 2009–2010	• Data – relational and multidimensional databases – MS SQL Server, MS Analysis Services • Dialog – analytical desktop, Consorg/Desk/Studio for primary users and Consorg/Web/forms for other users • Models – (1) Consolidation of financial statements for external reporting (IFRS). (2) Multi-dimensional simulations of capital sub-groups structure and elements of financial monitoring for management purposes • Communications – based on the work flow module responsible for monitoring the progress of the process • Creativity – not used
Black Red White SA One-layer capital group, 30 subsidiaries 5 primary users, 30 other users Implementation period: 2007–2008	• Data – relational and multidimensional databases – MS SQL Server, MS Analysis Services • Dialog – analytical desktop, Consorg/Desk/Studio for primary users and Consorg/Web/forms for other users • Models – (1) Consolidation of financial statements for external reporting and internal management purposes (IFRS). (2) Multi-dimensional simulations of capital sub-groups structure and financial planning, (3) Variance analysis and financial monitoring, (4) Corporate supervisory activities • Communications – based on the work flow module responsible for monitoring the progress of the process, intelligent software agent controlling the inference processes of the expert system • Creativity – (1) diagnosing the causes for deviations of the key performance indicators in three areas of financial performance: liquidity, profitability and long term debt. (2) benchmarking of the functions and processes of capital group management

Table 1 (cont.)

Company (capital group)	DDMCC Componets
Odra Trans SA Multi-layer capital group, 20 subsidiaries (including a Germany-based sub-group) 5 primary users, 30 other users Implementation period: 2006–2007	• Data – relational and multidimensional databases – MS SQL Server, MS Analysis Services • Dialog – analytical desktop, Consorg/Desk/Studio for primary users and Consorg/Web/forms for other users • Models – (1) Consolidation of financial statements for external reporting - PAS (Polish Accounting Standards) and IFRS. (2) Consolidation of financial statements for internal management purposes – simulations and financial monitoring using expert systems reports (3) Corporate supervisory activities • Communications – based on the work flow module responsible for monitoring the progress of the process • Creativity – not used

(i.e. cross section data analysis). Functionality applied only to those users who use cross-business information. MS Share Point – Enterprise Portal Management – is a main portal used as an operating platform for Consorg/Dominium modules (Interface Consorg/Dominium, Reporting Services engine for operational data, IBM/Cognos Report engine for more complex data presentation). MS Reporting Services – MS SQL Server service responsible for creating ad-hoc reports based on Consorg/Dominium relational database. Consorg/Dominium Relational Database is a main database used to store company's individual data and consolidation eliminations. Consorg/Dominium/Warehouse is a datamart used as a versioning and archive tool for transactional data (i.e. estimation of budget, predictions).

The ETL process is supported by IBM/turbointegrator or MS SSIS. OLAP databases are based on IBM/TM1 RAM OLAP. And finally the IBM/Cognos/Reporter empowers business users to access, modify or create reports quickly and easily. It meets all of your reporting needs with a self-service design that helps reduce the cost and time needed to share information throughout an organization.

The authors have had ample opportunities to test their approach to creative DSS development by implementing the concepts discussed above in business organizations. Practical applications have been delivered to some of Poland's largest enterprises. Table 1 gives an overview of the most advanced and challenging implementations.

5. Conclusions

The development of Decision Support Systems is tightly connected with large databases and with technologies of processing large amounts of data. Nowadays Business Intelligence solutions incorporate data warehouses, multidimensional OLAP databases and reporting tools as basic components. According to P. Gray both Business Intelligence (BI) and Competitive Intelligence (CI) are next stages in widening functionality and accessibility of information systems supporting decision making process [Gray 2003]. Using complex BI systems decision makers and analysts gain a new glance at their problems. They search for new ways of solving common problems, answering common questions. The effect of this activity is the demand for new tools and new technologies.

OLAP technology provides effective support for strategic processes and, as it can operate on quantitative data, is especially useful with identifying cause and effect chains. This approach is indeed commonly used with analytical software. Notably, some artificial intelligence components, such as expert systems or fuzzy logic solutions, can successfully handle qualitative data (symbols). It appears that combining the power of OLAP technology with artificial intelligence components capable of processing symbolic information may make it possible to build a technology platform which can offer effective support for strategic decision making for capital group management. It is very likely that the synergy effect arising from the integration of OLAP technology with intelligent systems will enhance applicability far beyond the many areas where each of the technologies alone has already been applied. The explicit knowledge representation, which is available to the user throughout the process of inference by the expert system, becomes a specific tool supporting strategic decision making for capital groups management.

In undertaking the research on the data-dialog-modeling-communication-creativity architecture we hoped to devise a useful framework within which to develop decision support systems that could truly rise to today's challenges, needs and expectations. This paper presents a summary of the authors' implementation work done within the consulting firm Consorg SA, aimed to verify the applicability of the proposed architectures in an effort to contribute to the progress of decision support theory and methodology. This ambition reflects our recent commitment to what we believe is the primary challenge for contemporary DSS research.

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SYSTEM WSPOMAGANIA DECYZJI OPARTY NA PARADYGMACIE DDMCC DLA STRATEGICZNEGO ZARZĄDZANIA GRUPAMI KAPITAŁOWYMI

Streszczenie: W artykule zaproponowano architekturę systemu wspierającego procesy konsolidacji finansowej w grupach kapitałowych, opartą na paradygmacie Dane-Dialog-Modelowanie-Komunikacja-Kreatywność. Przedstawiono także najważniejsze wdrożenia rozważanej koncepcji, realizowane przez firmę CONSORG SA, w polskich i międzynarodowych grupach kapitałowych. Jak podkreślają autorzy artykułu, wnioski płynące z obserwacji sposobów eksploatacji wdrożonych rozwiązań posłużą do dalszego doskonalenia proponowanego podejścia.

Słowa kluczowe: DSS, grupy kapitałowe, proces konsolidacji, paradygmat Dane-Dialog-Modelowanie-Komunikacja-Kreatywność, architektura hybrydowa.