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Review

Dedicated Business Intelligence System for SMEs Consortium

Katarzyna Rostek

Warsaw University of Technology, Faculty of Management, ul.Narbutta 85, 02-524 Warsaw, Poland.

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The paper proposes a new methodological approach to the organization and implementation of Business Intelligence in the SME sector. It is based on the assumption that SMEs do not have sufficient knowledge, skills and organizational, personnel and financial resources to make independent implementation of solutions of this class. On the other hand, such tools could have a significant impact on a growth of their competitiveness and strengthen their position in a competitive market. In this context, a new solution is proposed for design, implementation and deployment of the BI system, supporting the competitiveness management of SMEs.

Key words: SMEs, Business Intelligence, competitiveness, benchmarking, outsourcing, cloud computing, supporting of management decisions.

INTRODUCTION

The market of small and medium-sized enterprises (SMEs) plays a key role in shaping and developing the economy worldwide. Studies have shown that the SME sector is essential for the proper development of any economy because:

- Six out of ten new jobs are created in the SME sector;
- SMEs pave the way for the transformation of traditional forms of production into advanced technologies (Audretsch, 2001; Dibrell et al., 2008; Freel, 2003);
- SMEs play a key role in the development of innovations designed to improve market competitiveness (Audretsch, 2001; Low and Chapman, 2007):
- SMEs contribute to the development of the global market (Acedo and Florin, 2006; Karaganni and Labriandis, 2001; Lituchy and Rail, 2000; Salvato et al., 2007).

SMEs need to have strong competencies in order to survive in a changing environment and a growing competition (Teece et al., 1997; Tenai et al., 2009; Blackburn and Jarvis, 2010). In this respect, the possibility of consciously shaping the competitiveness of SMEs to ensure a stable market position becomes the key issue of management in this sector. The basic requirement that must be met in order to improve the management efficiency in the area of an enterprise's competitiveness is access to timely, complete and useful management information and the ability to effectively support decision making. These requirements can be best met through the deployment of Business Intelligence (BI) technology.

In the context of management, BI is a system or an IT solution based on production processes implemented in the enterprise and optimized for the flow of information between organizational units involved in the implementation of these processes. In terms of technology, BI is a specialized analytical and reporting software with a graphical user interface for processing and visualization of information for management decision support.

The implementation of a BI system entails compliance

E-mail: k.rostek@wz.pw.edu.pl. Fax: +48 22 849 97 98.

with other organizational and technological requirements and the commitment of resources. It can also lead to changes in the business management model. SMEs need support in each of these areas because they do not have the required: knowledge, trained personnel or financial resources that are sufficient for an independent and effective implementation of this type of solution. The present paper identifies SME constraints in the implementation of BI and proposes a methodological approach which will have a significant impact on these constraints.

Regarding the aforementioned obligations, the structure of the paper seeks to answer the following research questions:

RQ1: What are the needs of SMEs in the area of the Business Intelligence functionalities?
RQ2: What are the conditions precedent SMEs must meet in order to implement a Business Intelligence technology?
RQ3: What are the measurable effects of the implementation of a Business Intelligence system for SMEs?

In this context, the needs of SMEs in supporting managerial decision making (related to RQ1) is discussed. Also, we explore the conditions needed for the implementation of BI technology and the associated restrictions of SME sector (related to RQ2). The following section discusses the methodological approach to the design, the implementation and the deployment of a BI solution dedicated to SMEs (response to RQ1 and RQ2). And reports on a sample test of the method in a group of medical clinics (related to RQ3) are presented. Finally, the paper presents summary of the findings and then conclusions.

THE NEEDS OF SMES IN THE AREA OF MANAGEMENT SUPPORT SYSTEMS

In today's economy, competitiveness is considered an important determinant of business growth and is used for assessing the enterprise's market performance. Competition in a market economy consists of activities through which market participants present customers with more favorable offers to buy more attractive goods or services sold at more favorable prices, more powerful promotions than others, so as to meet their interests and the performance gains (Porter, 1998). Competition is recognized as the most important mechanism for promoting the most favorable solutions from the viewpoint of the economic criteria. It leads also to the development of an economy through unleashing the creativity of competing market operators (Garengo et al., 2005).

The above statements are particularly important due to the ongoing global crisis that has not left Poland and its business sector unaffected. This crisis is likely to last for years causing problems such as weak consumer demand and strong fluctuations in the financial market. This is why both new investments and changes to strengthen long-term competitiveness in relation to domestic and foreign rivals will be necessary for survival. Of particular importance will be the ability to combine these two components that is to invest in projects that would contribute to enhanced competitiveness. This is the main subject of this article.

However, Polish SMEs have serious problems developing and implementing strategic plans and short-term management aspects dominate over the long-term ones, as shown in research conducted by PARP[1] for many years. Future growth of competitiveness in the Polish SME sector is largely associated with the elimination of barriers limiting and sometimes even preventing their development (Żołnierski, 2009; Wilmańska, 2010; Brussa and Tarnawa, 2011; Tarnawa and Zadura-Lichota, 2012). The basic division of barriers to SME development can be either internal (dependent on the company) or external (influenced by market and global factors). Here are some barriers:

- Knowledge barriers leading to problems experience in strategic and operational management;
- Financial barriers resulting in investment and development issues;
- Personnel barriers leading to problems in productivity and quality of work.

External barriers may include:

- Economic barriers involving the problems that arise from general economic conditions and the legislative issues;
- Market barriers resulting in the problems of frequent changes to competition levels in the market.

The support of government organizations can be of paramount importance in the case of external barriers. Governments in many countries recognize the importance and impact of SMEs on the economy and so create organizations that support the development and the operation of this sector (Di Giacomo, 2004; Secrieru and Vigneault, 2004; Mason and Harrison, 2004; Cumming and MacIntosh, 2002). However, in the case of internal barriers companies should largely rely on their internal resources to address their own problems. Access to new technologies and modern management techniques to remove or reduce the impact of market barriers methods of management support for eliminating (or at least reducing the negative impacts) of the market barriers while taking into account the constraints posed by the financial and the personnel barriers. Researchers from

[1] PARP (pol. Polska Agencja Rozwoju Przedsiębiorczości) – Polish Agency for Enterprise Development.

PARP (Żołnierski, 2009; Wilmańska, 2010; Brussa and Tarnawa, 2011; Tarnawa and Zadura-Lichota, 2012) highlight the importance of implementing new IT technologies that will support enterprise management and help to obtain information that supports decision-making in the competitiveness development process. Therefore, the use of Business Intelligence technology seems to be the right solution as it will effectively support the development of a competitive SME sector. This leads to the formulation of the research question:

RQ1: What are the needs of SMEs in the area of Business Intelligence functionalities?

In order to answer RQ1, a quantitative research program was developed which was aimed at identifying the needs and capabilities of a selected group of SMEs in supporting managerial decision making. The test population included 150 dental clinics interviewed using the computer aided personal interview (CAPI) technique. The study was conducted in November 2009[2].

The total population of private dental practices in Poland amounted to 3,693 in 2009. The sufficient sample size for this set was determined under the following assumptions:

- Confidence level (1-α) = 95%;
- Confidence interval t = 1.96;
- Estimation of the population fraction has got analyzed characteristic p = 50%;
- Estimation of the population fraction has not got analyzed characteristic (1-p) = 50%,
- Maximum allowable error margin d = 8%.

The assumptions made it possible to determine the minimum size of the research group:

$$n = \frac{t^2 p(1-p)}{d^2} = \frac{1.96^2 * 0.5 * 0.5}{0.08^2} = 150.0625$$

The selection of respondents was carried out using a purposeful random method. Purposeful (arbitrary) sample was based on knowledge of the research population and the specific research goals.

The clinics included in the sample had to meet the following criteria:

- SME status; that is they must employ 2 to 250 people and generate an annual revenue of less than PLN 210 million;
- Provision of dental services: they employ 2 to 21 dentists;
- IT infrastructure in place: – own 1 to 60 computers;
- Located in 10 major Polish cities: Gdansk (11 surveys), Gdynia (5 surveys), Katowice (11 surveys), Krakow (9 surveys), Lublin (13 surveys), Lodz (9 surveys), Poznan (21 surveys), Sopot (1 survey), Warsaw (50 surveys) and Wroclaw (20 surveys).

Based on the aforementioned criteria, 150 dental clinics were sampled on a random basis. The sample was tested using CAPI (Computer-Aided Personal Interview). The aim of this study was to determine the needs of the research group in the field of support of decision making process. The following interview questions were clustered in four sections:

1. General information: the characteristics of the enterprises, the type and scope of the services offered, the level of IT in the company;
2. Decision making process: methods supporting the process of decision making, tools supporting this process, issues and challenges of the decision making process;
3. Data analysis: the level of willingness to be included in benchmarking, commitment to company analysis, , the readiness to incur costs of implementing and using IT analytics;
4. Business intelligence: existing knowledge of Business intelligence solutions, the level of commitment to BI, the readiness to use BI technology in business management.

The overall response to the second group of questions reveal that dental clinics largely rely on experience and intuition in their decisions making. Specifically, it is usually the experience of dentists who own the clinics that matters the most. Consulting external experts, market research and analytics, financial policy, legal and political conditions, incidents and random events scored much lower. On the one hand, the respondents the majority of whom were clinic managers, did not notice any deficits in up-to-date and complete information for their decision making processes. Yet, the very same people emphasize the need for a better access to information and efficient communication within the company. This suggests a problem in this area.

Similarly, in the third and fourth group of questions most respondents admitted using IT and analytical tools only to a limited extent. Most of them did not understand the term Business Intelligence or interpreted it as referring to the intelligence and level of education of managers. They do not see much sense in investing expensive IT solutions to support management decision-making.

The results obtained in the group of Polish dental clinics reflect the general level of knowledge and awareness in the SME sector in Poland. Strategically managed solely relying on in-house expertise and intuition, a few of the clinics actually went bankrupt within two months of this research project. However, there was a group of managers (about 35% of respondents) who argued that the management process would be much more effective if there were opportunities, time and skills

[2] Research funded from public sources in 2009-2011 as research project No. 0078/B/H03/2009/37.

to use additional information and knowledge gathered from the available data sources in the clinic. In this case a major condition is the availability of an IT tool that would be cheap and intuitive to deploy and use, and quite sufficient for the existing analytical needs. This was a strong premise for a need of building and implementing a Dedicated Business Intelligence system (DBI) for the SME sector and the input restriction for the RQ2 research question.

MAIN CONDITIONS TO IMPLEMENTING BI IN SMES

BI systems belong to the category of Decision Support Systems (DSS). They are information systems supporting business and organizational activities in the area of managerial decision making (Power, 2007; Finlay, 1994). Additionally, thanks to being adaptable, flexible, interactive and intuitive, BI is user-friendly and allows freedom and creativity of action (Turban, 1995).

The Business Intelligence term was first used by Luhn (1958) to describe the possibility of showing interrelations between analyzed facts in such a way as to facilitate the decision-maker achieving the intended business goals. Gartner Group[3] defines Business Intelligence as a user-oriented process of collecting, exploring, interpreting and analyzing data to streamline and rationalize the decision making process. Business Intelligence is also a computer system that uses a structured sequence of transformations of data collected by the enterprise to increase the efficiency of the decision making process by reducing the three types of delays resulting from the need to: prepare data for analysis, perform the analysis and deliver analysis results to the decision maker.

According to IDC[4] research, the Business Intelligence market is now the fastest growing IT sector and one of the few that have experienced growth in own value during crisis years. According to IDG[5] and SAS Institute[6] (Żółcińska, 2009) the reason for this that enterprises see in this category of IT solutions as an opportunity to gain competitive advantage (80% of surveyed companies) and overcome the effects of economic slowdown (70% of surveyed companies).

The SAS research mentioned earlier was conducted in over 80 medium-size and large Polish companies in 2009. It showed that the most important effects of the implementation of Business Intelligence system are (Żółcińska, 2009): better quality and availability of management information (62% of respondents), the opportunity to optimize and improve efficiency of business processes (60% of respondents), support reasonable reduction in operating costs (44%), increase management efficiency (40% of respondents), increase revenues (20% of respondents), improve customer relationships (16% of respondents), increase financial transparency within the enterprise (10%). The surveyed entrepreneurs use Business Intelligence tools in the management of (Żółcińska, 2009): finance (56%), strategy (38%), customer relationships (38%), supply chain (16% of respondents), production (16% respondents), marketing (12% of respondents), human resources (8% of respondents).

Although the survey was conducted among medium and large enterprises, Business Intelligence solutions vendors claim that SMEs buy them more and more often for the same reasons (DiS[7], 2010). This is possible because software vendors begin to see the needs of SMEs and their products are becoming more financially and organizationally available for this sector. However, there are still several necessary requirements associated with the implementation of BI systems in the SME sector that must be met. The following research question addresses these requirements:

RQ2: What are conditions precedent SMEs must meet in order to implement Business Intelligence technology?

Some of the conditions include:

- Process approach to business management;
- Business process reorganization to improve workflow;
- Acquisition of a sufficient amount of operational data necessary in the analytical processing;
- Developing the correct structure of the analytical database enabling in-depth, multi-dimensional analysis of operational data at the appropriate level of detail;
- Development of multi-dimensional analytical models for OLAP and data mining analysis to ensure the efficient acquisition of management information from their operational data;
- Providing a flexible distribution of analytical results in time, form and the most appropriate response to management decision makers.

However, as shown in survey results conducted among 150 dental clinics in the SME sector (in detail described in previous section), the most important restrictions on the use of IT tools in supporting decision-making are:

- Lack of technical expertise in the field of IT solutions for decision-making support;
- Lack of trained personnel, which could be addressed by implementing and maintaining such solutions;

[3]Gartner Group - international company with a global reputation in the area of the information technology analysis and consultancy.

[4]IDC (International Data Corporation) - one of the biggest ICT market research companies. It is involved in sectoral research and offers strategic advice in ICT projects. It focuses on identifying current and future trends in in the individual sectors of the ICT market.

[5]IDG (International Data Group) – An international provider of multimedia and marketing services, organization of conferences and meetings, scientific publishing, market research, consultancy of design and implementation and the dissemination of knowledge about modern IT technologies.

[6]SAS Institute – international IT Corporation classified as a Business Intelligence market leader.

[7]DiS - Polish Market Research Institute.

Table 1. Comparison of requirements and restrictions of SMEs with the capabilities of Business Intelligence technology (Source: own).

SMEs requirements for BI technology	Threat to implementation of requirement	Capabilities of BI system
BI system integration with the applied process management model	- Limited knowledge of business management (management based on intuition and experience) - Lack of trained personnel who could deal with the implementation and maintain such a solution	Requirement can be met provided the BI system is well designed and implemented
Automation of the key analytical and decision-making areas	- Limited knowledge of business analysis - Lack of expertise in the field of decision support systems	Requirement can be met if architecture well selected a BI system
Information and advisory support in the decision making process	- Limited knowledge of business management (management based on intuition and experience) - Limited amount of data collected, limited resources for BI technology financing	Requirement difficult to meet without consulting support
Price and technological availability of the proposed solution without sacrificing the expected functionalities	- Limited options to finance BI technology - IT departments in SMEs do not have a strong understanding of decision support systems - Lack of trained personnel who could deal with the implementation and maintain such a solution	Requirement difficult to meet without consulting support

- Limited knowledge among business management (management too often rely on intuition and past experience);
- Limited financial resources;
- Limited and often insufficient amount of operational data to feed into multidimensional analyses.

A comparison of the aforementioned restrictions with the requirements of the implementation of a Business Intelligence system, as defined in the introduction and presented capabilities of a classical Business Intelligence concept, is presented in Table 1.

While analyzing the results of Table 1 it can be noted that a conventional concept of Business Intelligence is not sufficient in relation to the requirements and constraints of SMEs. Therefore, it becomes reasonable to refer to the research conducted in the area of BI solutions. The following aspects exist for BI implementation which were addressed in existing research literature:

- BI integration into existing business processes;
- Development of the BI system architecture;
- Development of analytical methods and techniques used in BI;
- Development of approach to the design and implementation of the BI system.

The integration of Business Intelligence into existing business processes arises from the need to support not only the strategic, but also the operational management with one technology. BI decision support at the operational level must be preceded by the introduction of a process approach to business management and the availability of business process management on the system platform. The integration of the Business Process Management system (BPM) with BI creates an opportunity to use any data and information collected within company which are essential in making management decisions (Curko et al., 2007; Tan et al., 2008). On the other hand, a combination of Business Process Management with Business Intelligence enables optimazation of the results of process implementation. This leads to an increase in management effectiveness across the enterprise (Marjanovic, 2007, 2010).

Increasing the requirements for a range of supported data and the time horizon of their acquisition from source systems enforces the development of the data collection layer of BI. In order to ensure the integration of BPM and BI systems there is a need to create an analytical data repository which will collect, select, integrate and transform operational data, collected in real time. This function can be provided by a data warehouse and this is another subject of research work designed to: reduce the time of project creation and implementation of solutions (Inmon et al., 2008), optimize data and metadata model for speed, flexibility and accessibility of solutions (Zepeda and Celma, 2006; Zhang and Pan, 2010; Pan and Pan, 2010), and broaden the scope of its functionality, e.g. collecting spatial data (Malinowski and Zimanyi, 2007).

Operational data management and real time data processing also require changes in the organizational architecture of the BI system which are becoming as a multi-agent solution (Chunxu and Li, 2010), lowering the

cost of implementation and maintenance of BI (Venkatadri et al., 2010; Feng et al., 2010). Another technological and organizational solution aimed at lowering the costs of implementing and maintaining the system is SaaS BI (Hongfeng and Liya, 2009; Bitterer, 2011). SaaS BI means Software-as-a-Service Business Intelligence, also called On-Demand BI. Its main advantage is a pay-as-you-go system (e.g. you may choose to only pay for analytical) and there is no need to install and maintain your own IT solution. An extension of the BI service offer is provided by Cloud Business Intelligence, where services can cover each component of the system (Goel, 2010; Chadha and Iyer, 2010).

Architectural design is also accompanied by changes in methods and analytical techniques which has a significant impact on the design of BI solution. The development of BI analytical environment has recently shifted towards integration with Knowledge Management (KM) systems (Campbell, 2006). The layer of analytical data processing uses methods such as: fuzzy sets theory (Chen and Wang, 2010; Thomas et al., 2006) or the cognitive systems theory (Niu et al., 2007). A significant area of BI analytics development is the acquisition, processing, organizing and sharing of network information, based on the use of text mining (Chung et al., 2003; Zhou et al., 2007) and web mining (Tiwari et al., 2011).

The effectiveness of Business Intelligence is closely related to the scope of its functionality and the management area that it covers with its operation. In their twenty-year history analytical and reporting systems have developed a wide diversity of analytical tools, repositories, and areas covered by the analysis. Consequently, it is difficult to develop a cross-sectional report, involving more than one aspect of business management. It is also difficult to manage the quality and consistency of data stored in dispersed analytical repositories. The BI SOA architecture aims to address these issues by integrating a variety of analytical solutions and transforming them into a common BI structure (Wu et al., 2007; Javanmard et al., 2011; Ganapathy and Vaidehi, 2011). Then the BI environment development can be supervised by a competence center, which consists of representatives from various departments, and thus represents various areas, perspectives and approaches to management. This provides a deeper integration of the analytical environment in the area of the entire enterprise and a common BI development policy (Miller, 2005; Bogza and Zaharie, 2008).

In the longer term, with increased awareness and needs of the management, the Business Intelligence system evolves into a comprehensive Corporate Performance Management (CPM) system, which is used to support the overall management of the enterprise (Andonov-Acev et al., 2008; Shi and Lu, 2010). This type of comprehensive solutions are based on Active Data Warehouses functioning like operating systems which process operational data and provide information in real time (Brobst and Morris, 2002; Polyzotis et al., 2007, 2008; Qin, 2009). The concept of Corporate Performance Management was introduced by the Gartner Group in 2001, defining it as processes, methodologies, indicators and technologies used by the company for measuring, monitoring and business performance management (Wade and Recardo, 2001). The task of CPM is to integrate the previously used methods and management techniques, such as: managerial control, measures and measurements of results, management information systems or Balanced Scorecard. CPM integrates the various areas of management, optimizing their performance from the standpoint of the strategy implemented throughout the company, not just its individual departments. The basic functionalities of CPM solutions were defined by the Gartner Group, and should include (Paladino, 2007): planning and budgeting, profitability modeling, financial consolidation, reporting, applications that support the balanced scorecard, forecasting and optimization. With such a wide functionality, the CPM system allows instant access to the picture of the entire enterprise. It allows online evaluation of the quality of decisions, and use their results to plan and possibly correct current operations. Its purpose is to create a common management platform where conflict would be resolved and irregularities eliminated, resulting from the natural differences between the objectives of the various areas of management.

As can be noted, the research project is aimed at developing the BI technology through the development of system architecture, extending the area of possible applications and the use of an increasing number of available techniques and analytical methods. These studies however do not translate to the scope of applicability of analytical tools in Polish enterprises. According to research of IDC conducted in 2008, 75% of companies surveyed said they faced the phenomenon of information overload and that only 50% of the information available was really useful in making decisions. Sixty six per cent of these enterprises manually scour their IT systems to find the needed information and make the decisions without the support of data analysis. In the case of the SME sector, the percentage of companies using analytical tools is even smaller and according to research by IDG conducted in 2007 it was only 10% of the population. The reasons for this may include:

- Lack of awareness of the need to use tools to support the decision-making process;
- Organizational, human and financial limitations for the implementation of tools supporting the decision-making process;
- Uncertainty about the effectiveness of the results of the implementation of tools supporting the decision-making process.
- These obstacles can be overcome the applicability of BI

Table 2. Limitations of the BI technology for SME sector vs. the DBI System Concept (Source: own research).

Limitations of BI technology in SME sector	DBI
Lack of expertise in the area of possible management decision support systems	Shipped as the complete solution/ no need for high IT expertise
Limited expertise in modern business management methods and models	Architecture and structure of data model based on predefined model of key competitiveness factors dedicated to a specific group of enterprises
Lack of in-house capacity to implement/maintain a BI system	Implemented and delivered as a service (e.g. outsourcing, cloud computing)
Limited IT b budgets	Implemented, maintained and funded as a product shared by a group of enterprises rather than a solution for a single organization
Limited/insufficient amount of source data collected	Supports a whole group of comparable and competing enterprises by using their data and sharing all findings

technologies in the SME sector can be increased if the implementation process and adequate tools are mobilized so that they:

- Provide growth of competitiveness of the enterprise within the scope of implementation;
- Would are available in terms of organization, human resources and finances for the SME sector within the implementation, maintenance and development of the system environment.

The proposed methodological approach is designed to meet the needs of SMEs in supporting management decision making, also taking into account the restrictions on the use Business Intelligence technology in the SME sector.

NEW ORGANIZATION OF BI SYSTEM FOR A CONSORTIUM OF SMES

The proposed concept of DBI (Dedicated Business Intelligence System) is based on the assumption that SMEs receives a ready-to-use product which actively supports the development of its competitive strategy. This has a direct impact on the scope of the functionality of the BI tool but is necessary due to the low awareness of management and thus also to the lack of skills to use computer applications supporting the decision making process. This problem does not only concern the SME sector but all uses of advanced analytical systems which are not properly operated after implementation and consequently do not bring expected economic and performance outcomes. The proposed the BI solution has predefined modules equipped with a complete set of analyses and reports (dedicated to specific industry or business) and a data warehouse which integrates data collected from a group of enterprises.

With the adoption of a common DBI solution for a group of comparable and mutually competing enterprises a new, so far unknown functionality become available:. benchmarking. It is possible to determine the mutual competitive position of several organizations in one industry and use the experience of the group leaders while defining the individual strategy for competitiveness. Specific limitations defined in Section 2, in relation to the solutions proposed in the DBI system, are presented in Table 2.

The DBI system model is presented on Figure 1. A group of DBI users periodically supply their performance data. The data are integrated in a common repository, then processed analytically and shared with users in the form of ready-made analytical results, statistical summaries and reports. The data model and the analytical layer of the DBI system are dedicated to the needs of its users. In addition, the DBI system is delivered as a service, so the burden of managing the system is not on the users but on the provider. The whole solution is focused on minimizing costs and maximizing effectiveness.

Declarations contained in Table 2 and Figure 1 result from the design, implementation and exploitation requirements of DBI. A method of building such a solution is presented in Figure 2.

Stage 1 – Needs assessment and DBI feasibility study

Step 1.1 – Setting business objectives of the project

The complexity of BI system design requires detailed definition of business objectives and scope of the project. The purpose of implementing DBI is to support decision-making processes in managing competitiveness. Use of DBI for this purpose will result in:
- The ability to determine the current competitive position

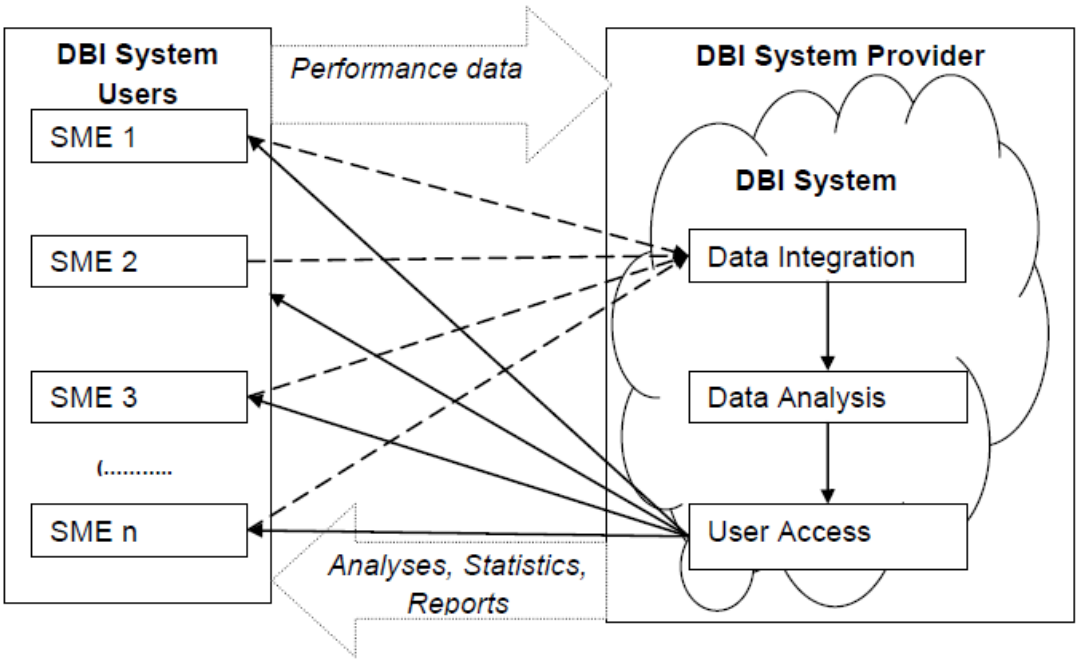

Figure 1. The model of the DBI system (Source: own research).

of the enterprise;
- The alignment of the competitiveness strategy to reach the target competitive position.

Step 1.2 – Analysis of the project feasibility

Estimating the risks and costs in relation to measurable and immeasurable benefits of implementing the DBI system. The analysis of project feasibility at this stage should lead to the identification of problems and limitations in such areas as current access to management information, business objectives and funding sources of the project, readiness to implement the solution, costs of designing, implementing and maintaining the system, and the expected return on investment period (ROI). The summary of the project feasibility study should provide objective answers to the following questions:

- Is the project necessary? Is it justified by potential benefits? What are the estimated losses if the project is not implemented?
- Is the project feasible? Is it financially and/or logistically possible to implement a complete DBI system in the enterprise?

If the answer to any of the above questions is negative the BI project should be postponed or cancelled. The enterprise may find it challenging if the question about the advisability of implementing a BI system is answered positively and the feasibility question is answered negatively. This is a typical situation in the SME sector. Meanwhile the author proposes such approach to the organization of the BI system (called DBI), which requires only a positive answer to the first question and then seek appropriate provider of BI solution in the cloud.

Stage 2 – Select BI vendors and DBI contractors

Step 2.1 – Select BI solution provider and method of DBI implementation

Based on the needs assessment in Stage 1, it is possible to look for a BI solution that would be available as a service and would be financially and logistically feasible to the enterprise. The use of outsourcing services implies that an external company would take the responsibility for maintaining and protecting all or part of implemented system infrastructure. There are several different ways of outsourcing services in the BI systems (Baars et al., 2007):

- Reporting service - outsourcing of tools to build analytical reports *via* the internet based solely on local data of the user;
- OLAP service - outsourcing of multi-dimensional analytic structure built on the basis of market data, which can be expanded on user's own data and integrated with its analytical system;
- Data mining and visualization of data service - the client uses an external service of professionals in the implementation and the presentation of results based on the

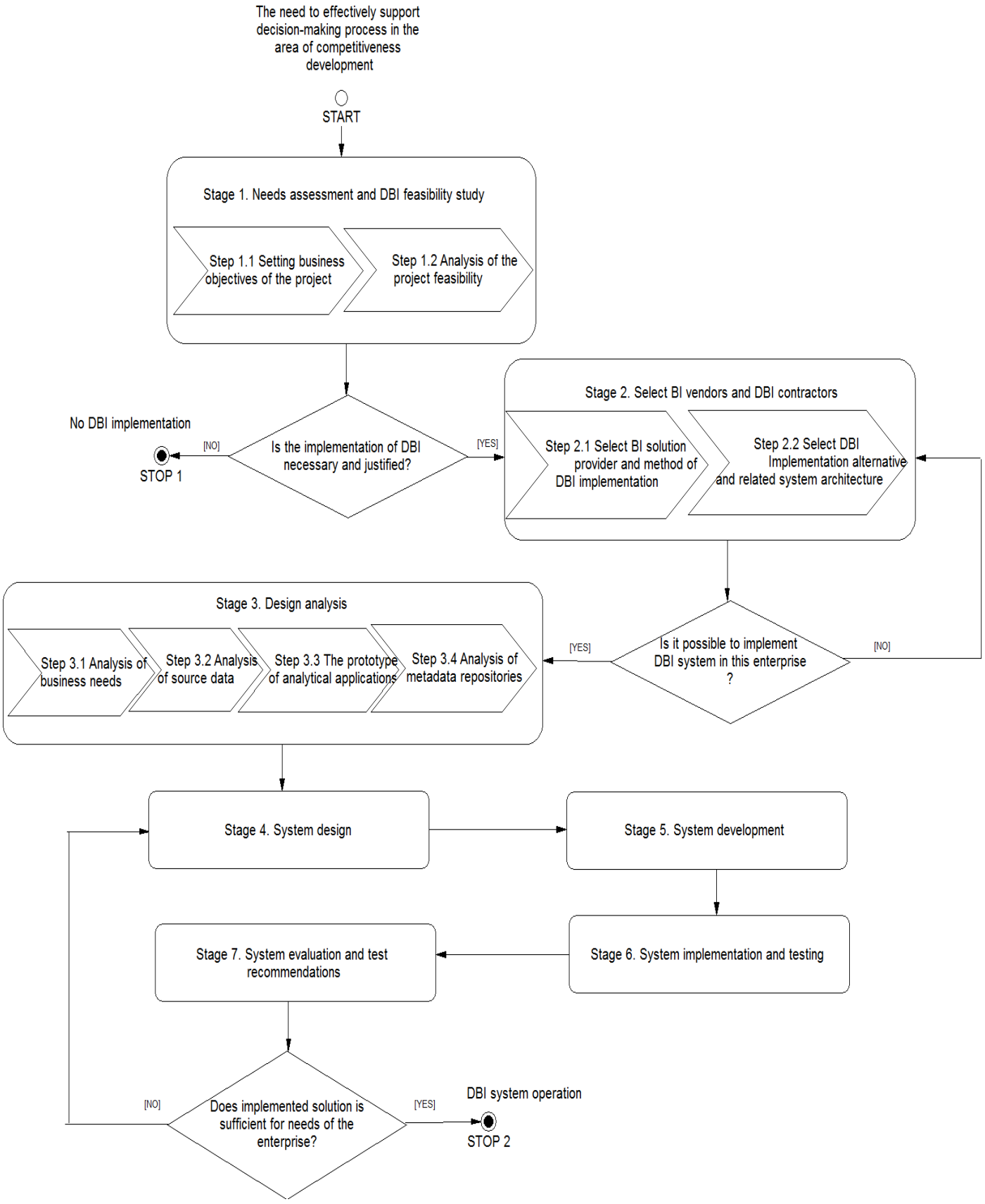

Figure 2. The method of implementing the DBI system (Source: own research).

resources of own collected data;
- Data warehouse and ETL service– supplying data into the data warehouse and maintaining its resources done exclusively by the equipment provider.

It is clear that these types of outsourcing services can be combined, e.g. data warehouse and ETL service with data mining and data visualization service. The type of the DBI system will have a direct impact on its architecture.

Step 2.2 – Select DBI implementation alternative and related system architecture

The choice of the implementation type of the DBI system offered as a service will have a direct impact on its architecture and the user competence in providing and maintaining system infrastructure, which includes:

- Technical infrastructure: hardware, software, network cabling, peripherals, database systems, operating systems, network components, metadata repositories, user applications etc.;
- Non-technical infrastructure: metadata standards, data mining standards, logical database model, methodology, manuals, test protocols, procedures for change control, change management procedures etc.

The choice of the DBI system implementation alternative is determined by answers to three basic questions:

- What parts of the DBI system can the enterprise maintain independently and what parts will it have to outsource?
- What data are available for analysis (quantity, quality and scope) and what is their level of confidentiality?
- How much is enterprise ready to pay for the implementation and maintenance of the DBI system?

The answers to these questions allow the selection of a package of internally implemented and outsourced services. The rights and responsibilities of the provider and the recipient must be carefully considered with respect to the management of the DBI architecture which needs to be kept up-to-date. With the dominating model of outsourcing most or all of the services, SMEs can also consider the DBI in the cloud option.

Cloud computing solutions are available in four versions of implementation: public, social, private and hybrid. From the perspective of maintenance costs the cheapest solution is a public cloud. From the perspective of safety and confidentiality of data processed the best solution is a private cloud. From the perspective of making benchmarking analysis in a group of enterprises which ensuring confidentiality and safety of data processed, the social cloud is the most recommended option. It is clear that the selection of implementation type should be based on the size of the budget and the needs for processing and analyzing data in the DBI system.

Stage 3 – Design analysis

Step 3.1 – Analysis of business needs

Whether outsourced or in a cloud, a set of system functionalities must be defined by the enterprise to meet the needs of users. Furthermore, the enterprise must be capable of ensuring that the system is well maintained (e.g. it must be prepared to pay a monthly maintenance fee).

It is suggested that the DBI system implementation should be preceded by the construction of a reference model of key competitiveness factors. The main goal of the model is to determine the competitive position occupied by the enterprise in the analyzed group. The model allows both: to conduct internal analysis of the enterprise's competitiveness and to compare its situation with respect to the competitive environment or other co-users of the DBI system. The results provide managers with the knowledge about the importance and the impact of the key identified competitiveness factors on the competitive position, which is then reflected in the strategy and results in an increase the efficiency of competitiveness development management. The reference model of key competitiveness factors helps the DBI system project develop into a sustainable and relevant decision-making and analytical tool.

Step 3.2 – Analysis of source data

Analyses are conducted in terms of: accessibility, quality and size of resource data collected by the enterprise. This leads to the development of the model of storage, processing and sharing of data through provider of the DBI solutions. The size and analytical power of data resources in the DBI system is greatly enhanced compared to single data resources through the integration of multiple external sources, derived from multiple SME users. This concept is consistent with the approach proposed by analysts of Gartner Group (Vijayan, 2011), who at Gartner BI Summit Conference in May 2011 proposed the output with BI system outside the enterprise by using not only internal but also external data sources. This postulate was seen as useful but very difficult to pursue. The proposed solution demonstrates how it can be achieved in practice.

Step 3.3 – The prototype of analytical applications

The analytical system which will operate under the project can be successfully achieved using the prototyping

method. This is a combination of analytical applications and IT tools oriented at well-defined analytical needs of the user.

Step 3.4 – Analysis of metadata repositories

As in the case of source data, the metadata will also be stored by the supplier's DBI solution. It should be also nuanced model of their storage and sharing. This model will condition the degree of independence of DBI users in a relation to possible changes in the individual layers of the system.

Stage 4 – System design

The system design is the responsibility of the solution provider and it is not a burden for the recipient of services. The design will consist of the following parts: analytical repository, ETL process, analytical applications, presentation layer and metadata repository. Using predefined industry-specific BI models can significantly accelerate and facility the DBI system design and implementation. Such type of solutions, very popular with data warehouse vendors, have now been increasingly offered by BI vendors. Each solution is customized but the time needed for needs assessment and system design is much shorter with each new implementation - it takes several weeks rather than several months.

Stage 5 – System development

The development of the system to be delivered as a service includes ensuring user access to the required set of functionalities and applications. The provider of the DBI system must develop the system in accordance with the design approved by the user.

Stage 6 – System implementation and testing

At this stage, the functionalities of the system are made available *via* a web browser and intuitive applications that do not require long and complicated training or IT skills. The whole solution is focused on minimizing implementation and training time and to run the system for the user as soon as possible.
Users of services provided also have the guarantee that their software will be constantly updated and any technical problems will be solved by the service provider. The enterprise pays for the use of specific application package or functionalities of these applications, as well as for maintaining and sharing the data collected. Yet, it does not have to bear the costs of maintenance, updating and servicing the system, which represents a significant fixed operating cost in any BI solution.

Stage 7 – System evaluation and test recommendations

The use of DBI system always leads to improved management awareness of the possibilities of using IT solutions in decision making process. Analytical and reporting needs of users are changing and they usually grow while the system is in place. If the system is supplied as a service its development is possible and available at any time at the request of the user. The provider takes the responsibility for delivering the expected modifications and all the customer is expected to do is to pay a potentially higher monthly fee.

The proposed approach to a DBI system offered as a service with a predefined analytical module and the database structure adapted to this module appears to be both affordable and feasible for SME customers. Tangible and intangible benefits from using that system are described in the next section.

BENEFITS FROM THE IMPLEMENTATION OF THE DBI SYSTEM IN A CONSORTIUM OF SMES

The implementation of such a complex project as the DBI system requires an assessment of the anticipated benefits from the implementation, which can be captured in the following research question:

RQ3: What are the measurable effects of the implementation of the DBI system for SMEs?

Every component of the system architecture has measurable and immeasurable impacts on the implementation of the DBI solution. The expected range of effects of the DBI implementation is shown in Table 3.

As seen in Table 3, if properly implemented and effectively used the DBI system will result in time savings, rationalization of costs and the optimization of management efficiency. The proposed system architecture also allows the enrichment of management experience by exposure to the experience of competing enterprises in the common market, according to good practices and ethical code of benchmarking.

The utility of the proposed solution was tested in a research experiment involving 10 dental clinics of the original group of 150 (covered by survey research). The data collected from these clinics were used to build the DBI system. The purpose of using the system was to determine the competitive position of each clinic in the group. A reference model of key competitiveness factors was developed as the structure of:

- Three identified areas of measurable effects (E1 - modernity and quality of medical services, E2 - the ability to meet the needs of patients, E3 - results of sales);
- Group of key competitiveness factors (C1- technological level, C2 – the quality of services, C3 - timeliness of

Table 3. Effects of the implementation of the DBI system for a Consortium of SMEs (Source: own research).

DBI feature	Measurable effects	Immeasurable effects
Analysis of competitive position of the enterprise	Maximization of profit, rationalization of costs	Support for setting goals and guiding the development of competitive strategy
Benchmarking results between co-users the DBI system	Maximization of profit, rationalization of costs	Competitive strategy driven by experiences of DBI co-users
Analytics and reporting	Budgeting	Less uncertainty the management decision process
Predictive analysis	Rationalization of costs of competitive growth	Fewer operational risk in the management decision process
Analytical data repository, data warehouse	Instant access to management information	Improved availability of analytical data for a wider range of users in any place and at any time
Multidimensional data processing tools	Queries and analyses less time consuming	Improved availability of analytics for a wider range of users in any place and at any time
Visualization tools, presentation and distribution of information	Instant reporting and dissemination	Improved availability of management information for a wider range of users in any place and at any time
ETL tools	Improved data quality also in transactional systems	Data standardization across the enterprise for all co-users the DBI system

service delivery, C4 - lasting relationships with customers, C5 - sales, C6 - costs and expenses, C7 - the utilization of fixed assets, C8 – the staff productivity) defined value of the competitive position CP for each enterprise in analyzed group.

Then benchmarking of the obtained results allowed for matching the strategy of competitive development to this competitive position which the clinic intends to take in this group in the future.

The results of the experiment confirmed the utility of the proposed DBI concept. The DBI system enhanced by the reference model of key competitiveness factors was more understandable, friendly and helpful to users than the IT solution equipped only with analytical and reporting tools. Users in the dental clinics could adjust their strategic plans and activities to their expected competitive position. Examples of practical applications of this solution and its effects were described in detail in (Rostek, 2012). The following assessment was carried out to provide evidence for the cost-effectiveness and efficiently of the DBI implementation.

It assumed that the payback period of a properly implemented and effectively used BI system should 3 years. Based on the results of an assessment of 180 systems (Burns, 2009) and Pentaho (Madsen, 2010) it can be concluded that the costs of implementation and maintenance of BI within the first three years of use are at a level of US$30,000 to 100,000 in small companies and US$ 30,000 to 400,000 in medium-sized companies. Referring to the cost of financial performance of the SME sector in Poland it can be said that the implementation of the BI system and maintaining it in its first year of life is a burden of 3.5 to 25.5% of annual earnings of a small company and 2.8 to 30% of average annual earnings a medium-size company. During the estimated 3 years of the payback period this load is 3.4 to 12% of 3-year earnings of a small company and 1 to13.5% of 3-year earnings of medium-size company. The upper limits of these ranges are a barrier to implementing a BI in SMEs.

By adopting the proposed DBI solution for a group of 12 small SMEs (total number of users is 25), the load in the first year of the system is less than 10% of the earnings of each company, and in the 3-year period below 3.5% of 3-year earnings of each of them (Table 4). Thus, for each of the project implementation, knowing the estimated costs as defined by the software vendor and the service provider, you can determine the optimal size of the DBI system user group the, which will reduce costs and increase the efficiency of its implementation.

Considering the effects of the use DBI solution in the research group a change in results is observed after using analytics and reports in 2008 to 2009 and their impact on the results of 2010 (Table 5).

Over 2-month periods of 2010 compared to the years 2008 to 2009 gross sales grew by an average of PLN

Table 4. The share of the DBI system cost in the financial results of the group of 12 small enterprises about 25 users (Source: own research).

Software vendor	Solution name	System cost / Financial result [%]	
		1st year of the system life	Within 3 years of the system life
Microsoft	SQL Server 2008 R2 Enterprise Edition	0.86	0.29
QlikTech	QlikView	1.36	0.69
Pentaho (Open source solution)	Pentaho Business Intelligence Gold Edition	0.86	0.86
SAP	SAP BusinessObjects Edge Professional Edition	4.54	2.05
MicroStrategy	MicroStrategy 9	6.28	2.85
IBM	Cognos 8 Business Intelligence	6.72	3.16
Oracle	Oracle Business Intelligence Suite Enterprise Edition Plus	9.17	4.16

Table 5. The DBI system efficiency in 2010 (Source: own research).

Period of analysis		Number of patients	Gross sales	Profit	Number of patient visits
2008-2009	On average within 2 months [PLN ,000]	4,714	319.00	28.00	2,011
	Per one patient visit [PLN]		158.64	13.73	
2010	On average within 2 months [PLN ,000]	18,742	603.00	97.00	3,760
	Per one patient visit [PLN]		160.28	25.68	
The difference: 2010-(2008/2009)	On average within 2 months [PLN ,000]	14,028	284.00	69.00	1,749
	Per one patient visit [PLN]		1.64	11.95	

284, 000 and profits earned in that period grew by PLN 69,000. Assuming that about 50% of this profit is a result of the use of prepared analyses and reports in the management process and that this trend will be permanent, it becomes possible to calculate the rate of return on investment ROI in one-year and three-year periods (Table 6).

Table 6 shows that clinics that act alone could implement only the cheapest solutions - Microsoft, QlikTech or Pentaho. However, as a group of 10 clinics, using a shared DBI system they can choose any vendor, even the most expensive in the market. In this situation the determinant of used technology does not have limited financial resources, but the actual analytical and information needs of an enterprise. This confirms the validity of the concept of group system implementation for the SME sector.

SUMMARY

The paper presents research results which reveal that Polish SMEs have not been heavy users of IT tools to support their management decision making. There is evidence, however, that suggests that the use of Business Intelligence solutions can significantly increase the quality of management decisions and reduce management risks.

The implementation of a typical integrated BI solution with development and maintenance cost borne by the enterprise seems too big a technical, logistical and financial burden for individual SMEs. One additional constraint is the low IT awareness of managers in the SME sector who have limited understanding and the advanced methods of data analysis. Further, companies do not collect insufficient amount of data. Therefore, an alternative approach is proposed to the development of a DBI solution:

- DBI system offered as a shared service for a group of SMEs;
- All DBI users supply their data into the system thus increasing informational and analytical system strength;
- The DBI system is based on predefined components

Table 6. ROI on the implementation of DBI by a single vs. a group of 10 clinics (Source: own research).

Software vendor	Solution name	ROI (1year) for single clinic (%)	ROI (1 year) for a group of 10 clinics (%)	ROI (3 years) for single clinic (%)	ROI (3 years) for a group of 10 clinics (%)
Microsoft	SQL Server 2008 R2 Enterprise Edition	35.64	1256.38	306.91	3969.13
QlikTech	QlikView	-14.49	755.11	68.58	1585.78
Pentaho (open source solution)	Pentaho Business Intelligence Gold Edition	35.64	1256.38	35.64	1256.38
SAP	SAP BusinessObjects Edge Professional Edition	-74.46	155.42	-43.54	464.62
MicroStrategy	MicroStrategy 9	-81.53	84.67	-59.31	306.91
IBM	Cognos 8 Business Intelligence	-82.75	72.52	-63.24	267.62
Oracle	Oracle Business Intelligence Suite Enterprise Edition Plus	-87.35	26.48	-72.10	178.97

with the key role played by a reference model of competitiveness factors dedicated to a specific group of SMEs;
- DBI offering an intuitive capability with predefined analytics and reports scenarios.

As seen earlier, a proper implementation and an effective use of the DBI system will result in time savings, rationalization of costs and the optimization of management efficiency. The proposed system architecture also allows the enrichment of own management experience by experiences of competing enterprises in the common market, according to good practices and ethical code of benchmarking. The proposed concept of The DBI system, as demonstrated by the results of the experiment, can efficiently support the development of strategies shaping competitiveness in SMEs. Therefore it is the prospect of develop BI technology and the possibility of its wider use in enterprises of all business sectors.

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