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Intelligent Dashboard for SME Managers. Architecture and functions

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***Abstract*—The article presents the main features of the InKoM project, whose aim is the realization and implementation of an Intelligent Dashboard for Managers. This project is conducted by a consortium led by the University of Economics in Wroclaw, and the other principal member is the company UNIT4 TETA BI Center. Credit Agricole Polska also participates in the project. As part of the project, an innovative Intelligent Dashboard for Managers will be developed, which is on one hand a complement, and on the other a development of the TETA BI system, that is the set of *business intelligence* tools offered on the market by UNIT4 TETA BI Center. The innovativeness of the InKoM system involves particularly the wide use of methods, techniques and tools for visual data mining of economic and financial knowledge. The InKoM will offer managers especially from micro, small and medium enterprises analytical and information functions not previously available to them, thereby increasing the quality, effectiveness, and efficiency of the decision making process.**

I. Introduction

NEW economic challenges require that decision makers of small and medium enterprises (SMEs) have current and appropriate knowledge of the economic situation of the enterprise and its environment. Because of that, decision makers must have the possibility to identify and analyze all indicators that may have impact on the operations of the enterprise. Analyzing information in the traditional way becomes very difficult, sometimes even impossible. However, discovering all dependences between various financial ratios is necessary, because they can indicate important trends, and alert one to anomalies and dangers [18, p. 85]. Decision makers in these enterprises, in comparison to managers of big companies, may have no access to much essential strategic information. Usually financial expertise is either not available or too expensive. Big companies have at their disposal strategic consultation and possess standard procedures to solve problems in the case of essential changes in environment. For financial and personnel reasons most SMEs cannot afford these types of facilities. Furthermore, SMEs operate in a definitely more uncertain and risky environment than big enterprises, because of a complex and dynamic market that has much more important impact on SMEs' financial situation than on big companies'. Tolerance of mistakes is narrower (see among others [9, p. 74-91]). In these conditions, SME's decision makers often act intuitively and as the result, the rationality of their decisions is decidedly smaller. Moreover, SME's decision makers often don't have a solid knowledge of economics and finance.

Currently existing Business Intelligence (BI) and Executive Information Systems (EIS) provide the functionality of data exploration from various databases and data warehouses. However, the usage of data exploration is very reduced to simple data mining algorithms and data aggregation. In order to interpret correctly economic ratios, not only their values are needed, but also knowledge of various relations between them. Decision makers expect from new ICT solutions that they would interactively provide not only needed and up-to-date information on the financial situation of their companies, but also explanations taking into account the contextual relationships.

The aim of this article is to present the architecture and functions of the Intelligent Dashboard for Managers (called further InKoM). InKoM system is developed by a consortium consisting of the Wroclaw University of Economics (WUE), which is the leader, and a company UNIT4 TETA BI Center Ltd. (TETA BIC).

II. The State-of-the Art and Related Works

The InKoM can be considered as an advanced Decision Support System integrated with Business Intelligence functions. Today Business Intelligence seems to be a very common commercial buzz-word used in publications and economic practice. One can notice that there is a variety of definitions and interpretations of the term (see among others [7], [12], [14], [21], [25]). Generally, we can say that BI is defined as an integrated set of tools to support the transformation of data into information in order to support decision-making (see also [21]). From a technical point of view, the architecture of BI can include: data warehouse, data marts, basic analytical tools (query engine reporting tools, On-Line Analytical Processing tools, data visualization tools), advanced analytical tools (such as statistical tools, data mining) and business applications (tools which provide analysis of specific business functions related to manufacturing,

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sales, customer relations, financial monitoring, etc.), and corporate portals.

The main goal of any BI system is to access the right data at the right time to allow proactive decision-making (see among others [7], [21], [26]). The users of BI systems expect access to more information, an interface easy to understand and use, and information presentation functionalities which should be intuitive and interactive and provide contextual and embedded knowledge [16]. Specific attention in BI systems is given to the user interface which should let the user among others: filter, sort and analyze data, formulate ad hoc or predefined reports, generate alternative scenarios, and produce "drillable" charts and graphs. However, existing BI solutions are designed primarily for people who can understand the data models and who have the time to design analyses, and provide information for others (see [20]). BI has to provide simple, personal analytical tools, using the built ontology, which supports the exploration of data sources, retrieval of relevant information based on semantic relations, and not requiring a priori knowledge about data structures and methods of data accessing (see among others [17], [20], [21]).

The usefulness of BI system is not dependent on the volume of generated information, but the amount and type of information which is required at the right moment.

The literature describes the development of BI systems towards BI 2.0 (using semantic search) (see [17], [20], [21]). This system may have the following features: proactive alerts and notifications, event driven (real time) instant access to information, advanced and predictive analytics, mobile and ubiquitous access, improved visualization, and semantic search information (see also [17]). The InKoM system should contain those features.

The BI system has acquired new capabilities through the use of such technologies as: Web 2.0 and 3.0, Service Oriented Architecture (SOA) and Software as a Service (SaaS). This system is directed at semantic analysis of data, using data and information from multiple sources (including external). One of the main artifacts to create a semantic network is the ontology, because the architecture of BI 2.0 has new components, such as ontologies, service ontologies and an application domain ontology (see [17]). The ontologies are used to create the necessary knowledge models for defining functionalities in analytical tools. In the design of InKoM many new features are integrated, such as topic maps applications created for six ontologies for the analysis of economic and financial indicators, semantic search, and tools in the visual searching of information for decision-makers.

Applying semantic technology to the analytical tools can solve the following problems (see [13], [21]):

- support for definition of business rules in order to get proactive information and advice in decision-making;
- a semantic layer describing relationships between the concepts and indicators;
- support to present information according to the different kinds of users that can be found in an organization;
- easy modification of existing data source and data warehouse structure (usually, structure changes demand the work of analysts, system administrators and programmers).

In InKom, the presentation layer is the most critical aspect of a BI system, since it broadly shapes the core understanding of the data displayed on their screen [26], because the system that enables information retrieval should be intuitive to use or easy to interpret by its users. A good interface contains good representation (helps users identify interesting sources) and efficient navigation (allows users to access information quickly) [11]. The basic assumption of navigation is that users should be able to view focus and context areas at the same time to present an overview of the whole knowledge structure [22]. The use of graphic interfaces is a primary characteristic of the new generation of BI applications (see [7]).

Visual exploration in InKoM is based on a standard Topic Map (TM – ISO/IEC 13250:2003). TM enables the representation of complex structures of knowledge bases [3] and the delivery of a useful model of knowledge representation (see [15, p. 174]), where multiple contextual indexing can be used. TM is a relatively new form of the presentation of knowledge, which puts emphasis on data semantics and the ease of finding desired information (see also [1]; [19, p. 30]). TM allows the organization and representation of very complex structures [10, p. 60] of the ontology of a domain. Additionally, the application of topic maps allows the separation of data of the enterprise information system from operational business activities (see among others [13]). Case studies using TM for analysis of economic indicators (see among others [5], [6], [13]) have shown that topic maps [4]:

- can be easily used for the representation of economic knowledge about economic and financial measures,
- can express the organizational structure,
- can be adapted to new applications and managers' needs,
- can be supportive of the managerial staff by facilitating access to a wide range of relevant data resources,
- can assure semantic information search and interpretation for non-technically-minded users,
- can visualize different connections between indicators that make possible the discovery of new relations between economic ratios constituting knowledge still unknown in this area,
- can improve the process of data analysis and reporting by facilitating the obtaining of data from different databases in an enterprise, and finally
- can be easily extended by users who are not IT specialists, e.g. by experts of economic analysis (using tools for creating a topic map application).

The results of the analysis of information requirements showed that there is a need for solutions that make it possible to obtain knowledge from different, scattered sources, and to integrate, to analyze and to present them in various layouts. Managers require also tools to discover new knowledge in an interactive way. In InKoM the TMs will be the main tool for visual data exploration (see [4]).

III. Aim and Purpose of Intelligent Dashboard for Managers

The main goal of the InKoM project is to create an intelligent dashboard for SMEs managers which will support decision makers in the area of analysis of economic and financial information. The system will contain a number of topic maps describing economic-financial ontologies, data exploration algorithms, and mechanisms for searching non-indexed information in the Internet. This solution will significantly widen existing BI and EIS functionalities. Some of these will be available also on mobile devices. In order to do that, many innovative IT solutions will be implemented.

The InKoM system is developed by the consortium composed of an IT research unit (WUE) and the software company (TETA BIC). Such a composition provides synergy of benefits resulting from cooperation in order to create an innovative solution dedicated to SME decision makers. As part of the project, WUE carries out all research and tasks requiring knowledge in economics and finance. In the project, the Department of Information Technologies fulfils the lead role with active support from the Department of Banking and the Department of Financial Investment and Risk Management.

The company TETA BIC provides software solutions and equipment making it possible to perform planned software engineering tasks.

Participating in the work on InKoM ontologies are experts from Credit Agricole Bank Polska S.A., who provide factual knowledge about economic and financial ratios.

The project lasts for 24 months and is divided into two phases. As part of the first phase (i.e. phase A), which lasts 18 months, eight tasks are defined. In order to increase the chance of completion of tasks on time, the project schedule was based on the Critical Chain Project Management method. This approach required preparing a detailed timeline of work (so-called subtasks). These will be accomplished by five research teams.

The second phase of the InKoM project (i.e. phase B) lasts 6 months. In this stage there are five tasks, which are typical actions for the implementation and deployment of the new product. Phase B will be mostly carried out by the company TETA BIC.

IV. Main Functions of the Intelligent Dashboard for Managers

The InKoM system will be used as dashboard dedicated for SME decision makers working also on mobile devices. Therefore,, a multimodal interface and inter alia various forms of information representation, human-computer interaction, and numerous alerts and task notifications will be elaborated. An important element in this dashboard will be the visualization of a semantic network of ontology created for specific fields of analysis of economic ratios. Results in this field have indicated the usefulness of this solution in searching for information using semantic dependences between economic ratios (see [5], [13, pp. 86-97]).

The Interface for the InKoM system will be designed in three variants. The first variant, called *Light*, is dedicated chiefly for small and micro enterprises where there is no need for advanced analysis of data and there are no complex information systems. The second variant, called *Extended,* is dedicated for small and medium enterprises using a enterprise resource planning system. The third variant, called *Full,* concerns a version integrated with the TETA BI system which is mainly designed for medium enterprises where data warehouse and online analytical processing systems are already implemented.

The essential element of the InKoM system will be a module containing topic maps for six created ontologies for selected areas of the analysis of economic and financial ratios. They will concern inter alia: Earnings at Risk, Cash Flow at Risk, Early Warning System. In order to do that, ontologies for specific fields will be conceptualized. That requires interdisciplinary expert knowledge, both theoretical and practical, in economics and finance. The domain knowledge about relations between economic and financial ratios will make the analysis and interpretation of contextual connections easier. This is very important in the case of SMEs, where a company doesn't employ experts in economic-financial analysis, and using outer consulting is too costly. Reproducing knowledge with the use of a topic map contributes inter alia to better understanding of economic concepts and interpretation of specific economic and financial indicators. In addition, in InKoM a semantic search will be applied to avoid difficulties related to decision makers' interpretation of economic and financial information. This gives the opportunity to search data sources taking into account not only structural dependences, but also semantic context.

The InKoM system will provide decision makers with methods of information exploration, data mining, and knowledge extraction from databases designed for SME managers. Data exploration algorithms (such as classification trees, association rules methods, clustering) integrated with topic maps (i.e. semantic search and visual data exploration), will be developed. In general, data mining tools currently available on the market contain many knowledge extraction algorithms, but a lot of them are not applicable for SMEs. Moreover some of them are too complex and their usage requires costly expert support.

V. Intelligent Dashboard for Managers: Assumptions and Objectives

In the previous part of the paper, the authors pointed out advantages to be gained from extending the existing EIS and/or BI systems. Mainly they include methods and techniques for visual data exploration and visual representation of economic and financial knowledge. To illustrate this point, the basic assumptions and objectives of the Intelligent Dashboard for Managers will now be discussed.

Figure 1 presents the main components of the InKoM: a comprehensive description of TETA BI system with examples of its application is available on the website: [23] (see also [2], [27]).

It can be seen that the InKoM uses TETA BI mechanisms for extracting source data from transactional systems (ETL), its data warehouse and analytical database. However, the

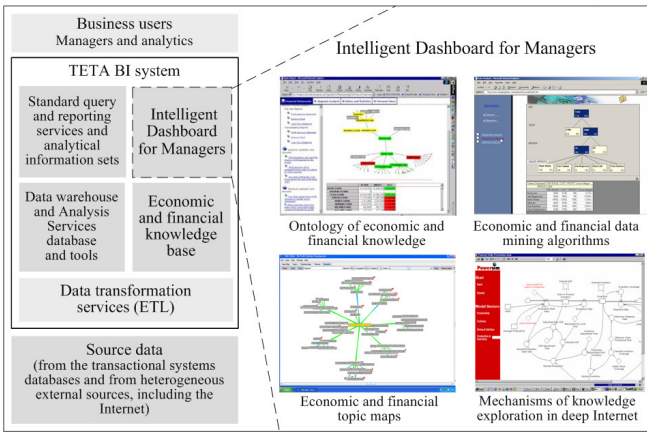

Fig. 1 Components of the Intelligent Dashboard for Managers and their location in the TETA BI system

available solutions – in particular standard analyses, reports and analytical statements generated by the system – are complemented by economic and financial knowledge – most importantly ontologies and topic maps – and economic and financial data mining algorithms, including mechanisms for extracting business knowledge from the deep Web. This enables a dynamic, on-line, interactive analysis of key economic and financial indicators and makes these much easier for users to understand, which is of special importance for SMEs managers.

The flow diagram in Figure 2 illustrates the operation of the Intelligent Dashboard for Managers and its interoperability with TETA BI system. The InKoM components and the processes performed by the system are indicated by shading. The diagram shows that the process of inputting source data to TETA BI and the InKoM data warehouses and databases is implemented through TETA BI ETL tools. The ETL package can extract data from various transactional systems, such as ERP TETA Constellation system databases (a detailed description of ERP TETA Constellation system is available on the website: [24] (see also: [8, pp. 91-111]) or other UNIT4 TETA business applications, including Navireo and other products from the InsERT, as well as the other internal sources of economic data of a company.

The possibility of extracting data from systems other than ERP-type solutions is particularly important for SMEs, where they are used (including TETA UNIT4 products) much more frequently than more expensive and more complex integrated business information systems. Mechanisms for extracting knowledge from the deep Internet, which increase the available sources of economic and financial knowledge, complement the standard ETL process.

The transactional data obtained from external sources, supplemented with planning data, e.g., budgets, form multidimensional data structures, or cubes, which are stored in a TETA BI Analysis Services database and provide a basis for the on-line, interactive creation of standard analytical queries and/or reports. The InKoM system complements and extends these processes. By providing economic and financial knowledge stored in ontologies and presented in the form of topic maps to facilitate the perception of concepts, it can make the processes under consideration more comprehensive and simpler. This is

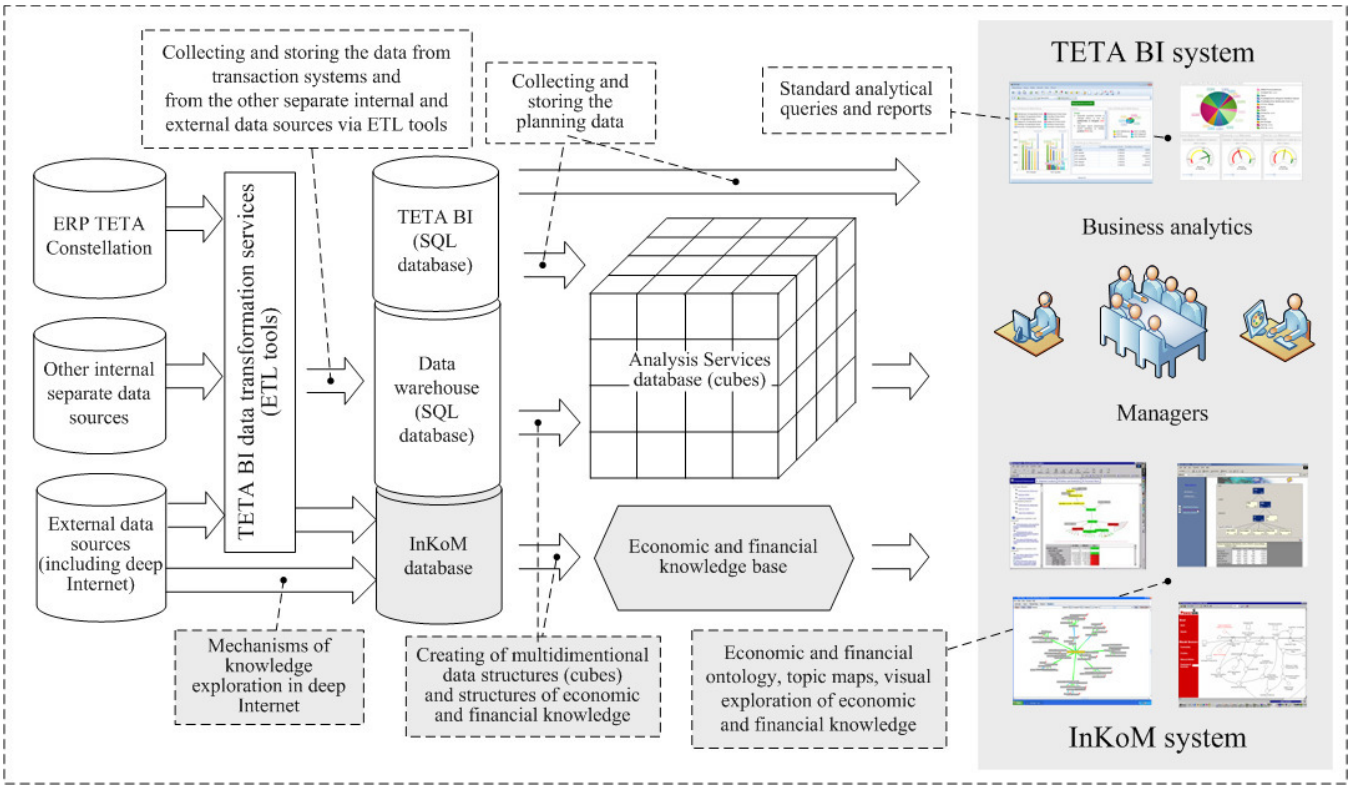

Fig. 2 Flow diagram illustrating the operation of the Intelligent Dashboard for Managers and its interoperability with TETA BI system

particularly important for users who are not specialists in the analysis and interpretation of economic and financial indicators, or users with a limited knowledge of relationships between different financial and economic ratios.

VI. Summary And Future Work

In this paper, the InKoM project was presented, with its main components. The project goals and partners were briefly described as well as the tasks related to the implementation of the InKoM system. The presentation focuses on both the position of the InKoM in the TETA BI system and the interoperability of the two systems.

It is now vital to ensure the integrity and interoperability of the InKoM. This applies both to security issues – protection against unauthorized access attempts, attacks and viruses – and to the integrity of data stored in databases and data warehouses, which are essential from the point of view of decision making by managers of SMEs.

The effectiveness of the final system will be examined and assessed in the course of the development of the InKoM system. The studies will be conducted on several levels: on the one hand, to take account of possible versions of the InKoM system and, on the other hand, of the perspective of the main beneficiary of the project, i.e. UNIT4 TETA BI Center, as well as that of SMEs that are intended to use the system. Further studies will be also conducted on, among others, financial methods, such as NPV and IRR, and methods specific to IT investment, such as TCO.

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