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MULTI-CRITERIA EVALUATION OF BI SYSTEMS. THE CASE STUDY OF INKOM DASHBOARD[1]

Summary: The article presents an approach to evaluate the BI systems applied in the InKoM project. The evaluation method is based on a scorecard framework, oriented towards Decision Support Systems and projects dedicated to the management supporting of small and medium enterprises (SME). To design the method, known existing BI maturity models, usability standards, and scorecard frameworks have been analyzed and adapted to SMEs area. Notably, the scorecard framework was extended to the new evaluation criteria associated with innovative functions created in the InKoM project, especially such as ontologies of economic and financial knowledge, and visual navigation and exploratory interface based on topic maps. The selected elements of the scorecard framework and usage in InKoM of multi-criteria evaluation are illustrated and discussed in this paper.

Keywords: BI system evaluation, intelligent dashboard, scorecard framework, InKoM project.

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1. Introduction

The current economic situation forces the decision-makers of small and medium enterprises (SMEs) to have at their disposal current and appropriate knowledge about the economic and financial situation of the enterprise and its environment. Because of that, decision-makers must have the efficient methods and tools to identify and analyze key performance indicators that have an impact on the operations of the enterprise. Analysis and interpretation of information in the traditional way becomes very difficult, sometimes even impossible. Discovering all dependences between various financial ratios is necessary, because they alert managers about anomalies and dangers (see [Olszak, Ziemba 2012]). Decision-makers in these enterprises, in comparison to managers of big companies, may not have access to all

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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 the business environment. For financial and personnel reasons most SMEs cannot afford these types of facilities. It should be noted that SMEs operate in a definitely more uncertain and risky environment than big enterprises because of a complex and dynamic market that has a much more important impact on SMEs' financial situation than on big companies' one. Tolerance of mistakes is narrower (see among others [Gibcus et al. 2009, pp. 74–91]). In these circumstances, SMEs' decision-makers often act intuitively and as a result, the rationality of their decisions is significantly weaker. Moreover, SMEs' decision-makers often do not have a solid knowledge of economics and finance.

In general, most existing Business Intelligence (BI) and Executive Information Systems (EIS) provide the functionality of data aggregation and visualization (see among others [Schlegel et al. 2013; *Wisdom of Crowdsâ Business…* 2013]). Many reports and papers in this domain underline the fact that decision-makers expect new ICT solutions to interactively provide not only relevant and up-to-date information on the economic and financial situation of their companies, but also explanations taking into account the contextual relationships.

The aim of this article is to present the approach to multi-criteria evaluation of BI innovative functions created and used in the Intelligent Dashboard for Managers (further referred to as InKoM). The InKoM system has been developed by the consortium consisting of the Wrocław University of Economics (WUE), which is the leader, and a company UNIT4 TETA BI Center Ltd. (TETA BIC). Crédit Agricole Bank Polska SA also participates in the project.

The main components of the InKoM and systems architecture have been widely described in many papers published by the authors (see among others [Korczak et al. 2012a, b, 2013a, b, 2014]). It can be explained that the InKoM uses TETA BI mechanisms for extracting source data from ERP and non-ERP transactional systems internally (ETL), its data warehouse, and analytical database. However, the available solutions – in particular the standard analyses, reports and analytical statements generated by the system – are complemented by economic and financial knowledge – most importantly ontologies and topic maps – 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 business indicators.

The transactional data obtained from external sources, supplemented with planning data, e.g., budgets in the form of 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, InKoM can make the analysis more

comprehensive and simpler. This is particularly important for users who are not specialists in the analysis and interpretation of economics and finance.

The structure of the paper is the following: In the next section the overview of approaches to evaluation of BI systems and projects evaluation is briefly described. The third section presents the discussion about extension of criteria of evaluation for BI functions oriented on SMEs. To illustrate the use of the extended scorecard framework, a case study of the InKoM Dashboard evaluation is characterized in the fourth section. The last section summarizes the work already carried out and points out the most important conclusions.

2. An overview of approaches to BI systems and projects evaluation

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 [Dudycz 2010; Wise 2008]). The users of BI systems expect access to useful information and knowledge through an interface easy to understand and use. However, most of existing BI solutions are designed primarily for users who are able to understand the business data models and semantic and/or algorithmic relationships between financial and economic objects/concepts (data, information, measure, key performance indicator, gauge etc.) used in analytical processes. Today the development of new BI systems is oriented towards BI 2.0 (using semantic search) and 3.0, Service Oriented Architecture (SOA), Software as a Service (SaaS), mobile BI, Big Data technologies using BI etc. (see among others [Howson 2013; Olszak, Ziemba 2012; Schlegel et. al. 2013; *Wisdom of Crowdsâ Mobile*… 2013]). The typical features of the systems include: proactive alerts and notifications, event driven (real time) access to information, advanced and predictive analytics, mobile and ubiquitous access, improved visualization, and semantic search information.

But no matter what BI applications we implement, they should always meet the expectations and needs of their business users. Helpful in achieving these goals can be the systematic, continuous and multi-criteria evaluation of BI systems and projects based on formalized and verified in practice approaches to BI evaluation process [Fedouaki et al. 2013]. The most important of these are:

1) BI Maturity Models,

2) BI commercial and non-commercial frameworks used to compare BI systems, projects and/or vendors,

3) BI scorecards,

4) Standards of BI systems and/or projects usability and quality,

5) Methods and tools dedicated for evaluation of economic efficiency of BI systems and/or projects.

There are many Business Intelligence Maturity Models (BI MM) developed by different authors such as Business Intelligence Development Model (BIDM), TDWI's maturity model, Business Intelligence Maturity Hierarchy, Hewlett Package

Business Intelligence Maturity Model, Gartner's Maturity Models, Business Information Maturity Model, AMR Research's Business Intelligence and Performance Management Maturity Model, Infrastructure Optimization Maturity Model, Ladder of Business Intelligence (LOBI), etc. All of these models and case studies of their use are widely described and compared in the available literature and on the websites of their owners, vendors and/or consulting firms applying them (see among others [*Describing the BI*… 2012; Eckerson 2006; Farrokhi, Pokorádi 2012; Fedouaki et al. 2013; Hribar Rajterič 2010; Lahrmann et al. 2011; Olszak 2013; Olszak, Ziemba 2012; Popovič et al. 2010]). Because BI Maturity Models primarily assess the maturity of BI solutions used in decision-making processes, BI frameworks are more useful for the evaluation of development projects of the BI application BI frameworks are used to compare BI applications, projects and/or vendors. Examples of selected frameworks to the evaluation of BI systems are presented in Table 1.

Generally, BI frameworks define the people, processes, platforms and technologies that need to be integrated and aligned to take a more strategic approach to business intelligence, analytics and performance management initiatives [Chandler et al. 2011, p. 1]. There is no single or right instantiation of the BI frameworks. Different configurations can be supported by the framework based on business objectives and constraints.

Often BI frameworks owners as consulting companies create and provide BI evaluation scorecards. A good example is the BI Scorecardâ (Table 1). The BI evaluation scorecard is a tool to support the evaluation process based on the multi-level pre-defined breakdown structure of the evaluation criteria and scoring technique. The changes of the scoring evaluation of BI system/project from the "as-was" to "as-is" and/or "to-be" status can be monitored and visualized and then can be used for the continuous improvement of BI initiatives. The structure and the few elements of BI Scorecardâ used to evaluate the InKoM system are described in Section 4.

The two last, but not the least, "sources of knowledge" need to create a system of evaluation that – as we noted above – use standards of BI usability/quality and methods/tools dedicated for measurement of economic efficiency of BI systems and/or projects.

In the first area the most important are ISO (IEEE, BSI) standards for software and/or systems usability and/or quality evaluation such as "the old" ISO/IEC 9126 (usability), "the new" SQuaRE (Systems and software Quality Requirements and Evaluation) ISO/IEC 25000:2014, 25010:2011, 25051:2014 and ISO 9241-171:2008 (ergonomics of human-system interaction). The ISO standards defined usability as the software's capacity to be understood, learned, used, and to be attractive to the user in specific use conditions. ISO also establishes four basic principles on which usability is based: ease of learning, ease of use, flexibility, and robustness. These principles were used in the heuristic evaluation of user interface (e.g. dashboards) based on topic maps and visual navigation as a part of the InKoM system usability evaluation [Dudycz 2011, pp. 50–58].

Table 1. The comparison of selected frameworks to the evaluation of BI systems

Owner and framework solution	Gartner (Business Intelligence and Analytics Platforms Magic Quadrant and Gartner's Business Analytics Framework)	Dresner Advisory Services (Small and Mid-Sized Enterprise Business Intelligence Market Study)	BI Scorecardâ (BI Scorecard Evaluation Frameworks)
Main (1st level) evaluation categories and selected (2nd level) subcategories	1. Integration: 1.1.BI infrastructure 1.2.Metadata management 1.3.Development tools 1.4.Collaboration 2. Information Delivery 2.1. Reporting 2.2. Dashboards 2.3. Ad hoc query 2.4. Microsoft Office integration 2.5. Search-based BI 2.6. Mobile BI 3. Analysis 3.1.Online analytical processing (OLAP) 3.2.Interactive visualization 3.3.Predictive modelling and data mining 3.4.Scorecards 3.5.Prescriptive modelling, simulation and optimization	1. Ability to write to transactional applications 2. *Ad-hoc* query 3. Advanced visualization 4. Big data support 5. Collaborative support for group-based analysis 6. Complex event processing 7. Data mining and advanced algorithms 8. Data visualization 9. End user "self-service" 10. In-memory support 11. Interactive analysis 12. Personalized dashboards 13. Pre-packaged 14. Vertical/functional analytical applications 15. Production reporting 16. Social media analysis (Social BI) 17. Text analytics/Data integration/ Data quality tools/ETL 18. "Embedded" BI	1. Information delivery and business intelligence reach 2. Business query and reporting 3. Production reporting 4. OLAP support 5. Dashboard capabilities 5.1. Dashboard layout 5.2. Dashboard design 5.3. Presentation 5.4. Alerting 5.5. Analysis 5.6. KPIs/metrics 5.7. Dashboard interactivity 5.8. Delivery 5.9. Architecture 5.10. Other 6. Delivery and Exploration 7. Spreadsheet Integration

Source: own elaboration based on [Chandler et al. 2011; Howson 2008; Howson 2013; Schlegel et al. 2013; *Wisdom of Crowdsâ Business*… 2013; *Wisdom of Crowdsâ Mobile*… 2013; *Wisdom of Crowdsâ Small*… 2013].

The important part of the BI evaluation framework concerns the economic efficiency/effectiveness of BI systems and/or projects (see among others [Ghilic-Micu et al. 2008; Whittemore 2008]). From this point of view, the evaluation of a given solution represents a process of analysis of costs, benefits and risks, of BI solution, which must be done by a team of both business and IT personnel. The initial evaluation is followed by a series of analyses made before the start of the project (*a priori*) and after each year of use in order to verify the initial estimation and to adjust the BI solutions.

The main problem that confronts the current frameworks for the measurement of BI solutions is the fact that much of the benefits are strategic benefits, hard to quantify and only appearing several years after the implementation of the solution. Thus, many of the effects of the BI solution are nonfinancial, sometimes intangible effects that lead to financial results after a certain period of time. These benefits come from improved decision-making, and increased quality of information, and often are not financial incomes directly quantifiable (see among others [Ghilic-Micu et al. 2008; Gibson et al. 2004; Whittemore 2008]).

There are different methods to evaluate an investment into IT (including BI) solutions. The most important of these is the Cost-Benefits Analysis (CBA) method based on discounted cash flows. CBA used well-known and widely recommended detailed measures and indicators such as IRR (Internal Rate of Return), MIRR (Modified Internal Rate of Return), NPV (Net Present Value) and ROI (Return On Investment). CBA can be extended by the TCO (total cost of ownership) analysis, where TCO/ROI calculators can be used. A good example of such a tool is TDWI Business Intelligence ROI Calculator (www.tdwi.org).

All of these presented "sources of knowledge" are very useful to design multi-criteria evaluation of BI systems and projects. But as a lot of works have noted, most of them are available for large or mid large companies (see among others [Fedouaki, Okar, El Alami 2013; Olszak, Ziemba 2012]). However, none of these tools address the project of designing and implementing BI systems in SMEs specifically. Also, there is a lack of guidelines informing how to create BI systems that might be used as reference examples for SMEs.

There is a very important need, because of the role of SMEs as catalysts for the EU (and also Polish) economy, to accelerate SMEs' growth and to improve their competitiveness. This is recognized by the European Commission which has developed the set of 10 principles to guide the design and implementation of policies both at EU and Member State level, called "Small Business Act" (SBA). The VIII principle of SBA specifies that "The EU and Member States should promote the upgrading of skills in SMEs and all forms of innovation. They should encourage investment in research by SMEs and their participation in R&D support programmes, transnational research, clustering and active intellectual property management by SMEs" [*Think Small First*… 2008].

Therefore in the next section we discuss the extension criteria of BI evaluation frameworks for BI functions oriented on SMEs.

3. The InKoM project and the extension criteria of BI evaluation frameworks for functions oriented on SMEs

SMEs may differ from larger companies by a number of key characteristics, e.g. resource and knowledge limitations, lack of money, reliance on a small number of customers, and need for multi-skilled employees. Some of the above-mentioned characteristics are putting a greater strain on the SMEs, causing the successful implementation of BI to be possibly more challenging in this context.

SMEs are socially and economically important and need tools and solutions to preserve their competitiveness in challenging environments, particularly because they operate in highly competitive, turbulent and uncertain markets. Usually they do not have control or influence over the market and thus they need to adopt a reactive approach and adapt to market changes.

Scarcity of resources is one of the main problems and a typical characteristic of SMEs. In addition also skills are limited, not only among staff, but also owner-managers often do not have enough managerial expertise or organizational capabilities, and this implies poor strategic business planning and human resource management.

Some of the research has mentioned that for a successful BI project implementation and to bring tangible business benefits to SMEs in the future, it is necessary to meet the following critical success factors: well defined business problem and processes, well defined users' expectations, adjusting the BI solution to users' business expectations, integration between the BI system and other systems, data quality and the flexibility and responsiveness of BI on users' requirements, appropriate technology and tools, and "user friendly"/usability of BI system (see among others [Fedouaki et al. 2013; Olszak, Ziemba 2012]).

The analyses presented in the report *Small and Mid-Sized Enterprise Business Intelligence Market Study* specified that "making better decisions" was the most-sought outcome of BI, but SMEs show an even higher regard for revenue growth and competitive advantage stemming from Business Intelligence than their larger peers [*Wisdom of Crowdsâ Small*… 2013, p. 15]. The technology priority changes among SMEs 2012–2013. Only three technologies related to BI increased in importance over 2012: Software-as-a-Service (Cloud BI), Dashboards, and Mobile Device Support [*Wisdom of Crowdsâ Small*… 2013, p. 25]. For 2013, top technologies related to BI in SMEs included: Dashboards, End User "Self-Service", Advanced Visualization and Data Warehousing [*Wisdom of Crowdsâ Small*… 2013, pp. 35, 36]. The same survey noted that at SMEs, Executive Management, Sales, Finance, and Strategic Planning are most likely to drive BI initiatives and projects. Small Enterprises of one to 100 employees are the most likely of all to see Business Intelligence driven by Executive Management (which might describe CEO, CFO, COO or other titles) and are more likely to be driven from the Sales function [*Wisdom of Crowdsâ Small*… 2013, p. 26].

Features of SMEs and analysis of the BI market for SMEs indicate the directions of the development of modern BI systems. These directions are included in the InKoM project. In the development of InKoM, many new features are integrated, such as domain ontology covering key concepts of corporate finance and economics, knowledge discovery algorithms, semantic search mechanisms, explanation facilities, and tools for visual navigation in domain knowledge.

One of the main parts of modern BI systems is the ontology. In general, the ontology is used to define the necessary knowledge (see [Korczak et al. 2013a, b]).

In the InKoM project, six ontologies were built, covering economic and financial areas: Cash Flow at Risk, Comprehensive Risk Measurement, Early Warning Models, Credit Scoring, the Financial Market, and General Financial Knowledge. Integration of these ontologies into the BI systems assures:

- support for the 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;
- relevant information according to the different kinds of users that can be found in an organization;
- effective usage of existing data sources and data warehouse structure [Korczak et al. 2013b].

All of these benefits require the extension of the evaluation criteria of BI systems for domain-ontologies category.

The knowledge representation layer is the most critical aspect of a BI system, since it broadly shapes the core understanding of the information displayed on their screen [Wise 2008]. In InKoM design, the basic assumption of navigation was that managers should be able to view focus and context areas at the same time to present the relevant knowledge structure.

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 and the delivery of a useful model of knowledge representation, where multiple contextual indexing can be used. Developed topic maps for analysis of economic indicators (see among others [Dudycz 2010, 2011; Korczak, Dudycz 2009; Korczak et al. 2013a, b; Sabol et al. 2012]) have demonstrated that the system [Dudycz 2012]:

- 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 a 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 in economic analysis (using tools for creating a topic map application).

In turn, this group of features and benefits requires the extension of the evaluation criteria of BI on visual navigation and a data exploration interface based on standard topic maps categories.

This is very important in the case of SMEs, where a company does not employ experts in economic-financial analysis and using external consulting is too costly. Reproducing knowledge with the use of a topic map contributes inter alia to a better understanding of economic concepts and the interpretation of specific economic and financial indicators.

Data exploration algorithms (such as classification trees, association rules methods, clustering) have been integrated with topic maps (i.e. semantic search and visual data exploration). 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.

The data exploration module in InKoM not only is integrated with topic maps/ontologies and contains data exploration methods and algorithms dedicated for SMEs, but also is simple to use for non-analysts. Managers in the data exploration process use the built-in wizards to build step by step data mining models (see [Dyczkowski et al. 2014, Fig. 3] and [Korczak et al. 2014, Fig. 7]).

These features require the extension of the evaluation criteria of BI related to topic maps/ontologies, dedicated to SMEs' exploration methods and built-in wizards, and explanation facilities of concepts/KPIs for SME managers.

4. Case study – evaluation of innovative functions of the InKoM Dashboard

4.1. Our approach to BI systems and project evaluation

Our project team are not a consulting company and/or an evaluator of the BI initiative and/or products market. But during the InKoM project many times (*ex-ante*, periodically, *ex-post*, etc.) we had to make several evaluations of the project and the InKoM system:

- compliance with the National Research and Development Centre requirements,
- self-evaluation,
- evaluation by external experts (end-users from SMEs, BI experts, financial and economic experts, etc.).

Our evaluation system is focused on our project (Intelligent Dashboard for Managers InKoM and TETA BI system), therefore our approach to BI systems and project evaluation is based on the following key assumptions:

- consideration of the new functionalities and characteristics of the created system InKoM (see the previous section of the paper),
- opportunity to use for the internal (self-assessment) and external evaluation (external experts and SME managers),
- compliance with the National Research and Development Centre requirements,
- easy to use, low cost, open criteria system, transparent and easily understood for SME managers.

The evaluation procedure consisted of four basic steps:

- identification and analysis of available approaches to BI systems and projects (it includes within its scope all of approaches to evaluation described in section 2),
- selection of the approach to be used in the InKoM project (our chose as we previously described has been scorecard framework),
- extension of the evaluation criteria taking into account the new functionalities implemented in the InKoM system and SMEs requirements and limitations,
- evaluation (with the pilot phase including testing, iterative modification and implementation).

4.2. Selected results of the evaluation

Evaluation of the InKoM Dashboard based on categories and subcategories used in BI Scorecardâ with extensions was defined in the section 3. All ratings were exposed using an approach based on the Delphi method. "As-was" assessment was issued on the basis of self-assessment by TETA BIC specialists. In turn, "as-is" assessment was prepared on the basis of internal expertise (developed by InKoM project teams from TETA BIC and WUE) and external expertise (developed by experts from universities and/or research centers and SME's managers; the structure of external experts is presented in Table 2).

Table 2. The structure of domain external experts have taken part in InKoM project evaluation

Domain	Expert characteristics
Topic maps, ontologies, intelligent systems	research center, not TETA BI user
HCI, usability evaluation of ICT solutions	university, not TETA BI user
BI systems, DSS	university, not TETA BI user
Data mining, Data exploration	university, not TETA BI user
Finance and economy	university, not TETA BI user
SME manager	business, not TETA BI user, not finance/economics background
SME manager	business, not TETA BI user, with finance/economics background
SME manager	business, TETA BI user, with finance/economics background
SME manager	business, TETA ERP user, with finance/economics background
SME managers and/or IT staff from SME (only questionnaire survey participants)	TETA ERP and/or TETA BI users (40 person)

Source: own elaboration.

All internal and external experts have used InKoM documentation (reports, manuals, specifications, etc.) and have accessed the prototype of InKoM system (via remote desktop and/or in InKoM lab located on WUE). TETA BI users' needs/ requirements were verified via additional questionnaire survey. Additional evaluations of InKoM usability and economic efficiency were made by InKoM project team.

The results of the evaluation have been widely discussed on the FedCSIS/ AITM'2014 Multi-conference and have been published in the paper [Dyczkowski et al. 2014, section 4]. Therefore, only selected results of the evaluation are reported in this paper. The detailed requirements for dashboard evaluation are presented in Tables 3–5, namely:

- the dashboard interactivity category evaluation (Table 3),
- the delivery and other category evaluation (Table 4),
- the more important and/or valuable changes of evaluated criteria (Table 5).

Table 3. The dashboard interactivity category evaluation – detailed requirements

Dashboard interactivity – detailed requirements	as-was	as-is
Global filter for all gadgets in dashboard	0	0
Re-sort data in a table within an existing dashboard	2	2
Drill-down	2	3
Pivot / drill by other dimensions	2	3
Drill from one dashboard to another with context passed	0	1
Sliders / Lassos to select content	0	0
Flash animation	0	0
Overall usability and navigation	2	3
Interactivity based on new visual tools (topics maps)	**0**	**3**
Average value	0,89	1,67

Source: own elaboration. See also [Dyczkowski et al. 2014, Table 8].

Table 4. The delivery and other category evaluation – detailed requirements

Delivery and other– detailed requirements	as-was	as-is
Print whole dashboard	2	2
Export to PDF	2	2
Export to Excel	2	2
Disconnected access	0	1
Live Excel connectivity	0	0
Guided analysis / workflow / link reports	1	2
Annotations /Collaboration	1	2
Integration with ontologies and topic maps	**0**	**3**
Average value	0,89	1,67

Source: own elaboration. See also [Dyczkowski et al. 2014, Table 10].

Table 5. The more important and/or valuable changes of evaluated criteria

Evaluation category and subcategory	as-was	as-is
Analysis (average value of all subcategories)	**1,00**	**2,20**
Predictive analysis / what if	0	2
Advanced analysis (based on data exploration)	0	2
KPIs / metrics	**1,20**	**2,20**
Predefined KPIs / metrics dedicated for managers	1	3
Dashboard Interactivity	**0,89**	**1,67**
Interactivity based on new visual tools (topics maps)	0	3
Delivery and other	**1,00**	**1,75**
Integration with ontologies and topic maps	0	3

Source: own elaboration.

The evaluation of the InKoM system, especially the dashboard categories and subcategories (see the "greyed" and/or "bolded" cells), shows necessities for improvement of the BI evaluation frameworks and their customization to SMEs solutions and new innovative technologies and concepts.

5. Summary and future works

In this paper, the multi-criteria evaluation of the Intelligent Dashboard for SME Managers used in the InKoM project environment was presented. Further studies will be conducted on empirical verification of the created framework in "real" SMEs, extension of the evaluation categories to support CBA analysis and measurement of ROI/TCO, and creation of a community of experts to continuously extend and update the evaluation tools.

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WIELOKRYTERIALNA EWALUACJA SYSTEMÓW *BUSINESS INTELLIGENCE*. STUDIUM PRZYPADKU KOKPITU MENEDŻERSKIEGO INKOM

Streszczenie: W artykule przedstawiono podejście do ewaluacji systemów *Business Intelligence* (BI) zastosowane w projekcie InKoM. Metoda ewaluacji opiera się na ramowej karcie wyników, zorientowanej na systemy wspomagania decyzji (DSS) i projekty DSS wspomagające zarządzanie w małych i średnich przedsiębiorstwach (MŚP). Opracowując metodę ewaluacji, przeanalizowano i dostosowano do obszaru MŚP znane, dostępne na rynku modele dojrzałości BI, standardy użyteczności i ramowe karty wyników. Warto zauważyć, że ramowe karty wyników zostały rozszerzone o nowe kryteria oceny, związane z innowacyjnymi, opartymi na wiedzy funkcjonalnościami stworzonymi w projekcie InKoM, w szczególności takimi jak ontologie wiedzy ekonomicznej i finansowej oraz interaktywny, wizualny interfejs nawigacji i eksploracji oparty na mapie pojęć. Wybrane elementy rozszerzonej ramowej karty wyników oraz procedura jej zastosowania w wielokryterialnej ewaluacji projektu InKoM są przedstawione i omówione w niniejszym artykule.

Słowa kluczowe: ewaluacja systemu BI, inteligentny kokpit menedżerski, ramowa karta wyników, projekt InKoM.