Agile Development for Service Oriented Business Intelligence Solutions

Marinela MIRCEA, Anca Ioana ANDREESCU
Economic Informatics Department, Academy of Economic Studies, Bucharest, Romania
mmircea@ase.ro, anca.andreescu@ase.ro

Considering the evolution of information and communications technology, the necessity of alignment of public and private sectors to European Union requirements, the current economic crisis, and the global context, all organizations are trying to achieve major changes that would enable them to operate as intelligent organizations. For this purpose, agility and Business Intelligence are seen by most managers as a way to transform their organizations into intelligent organizations. The study highlights the importance of modern approaches (Service Oriented Architecture, Business Process Management, Business Rules, Cloud Computing, Master Data Management) in developing agile Business Intelligence solutions. The paper also presents the stages of developing an agile Business Intelligence solution in the case of public procurement.
Keywords: *Business Intelligence, agile development, service oriented architecture, business process management, business rules, public procurement*

1 Introduction

Given the characteristics of the knowledge society, the need to align legislation with the European Union (EU) requirements and the level of private sector development, the Romanian public sector made permanent change in its organizational structure, administrative practices and management systems. One current concern of public institutions is the creation of intelligent institutions through the efficient spending of public funds. This involves the necessity of monitoring the progress of institutions and the way they adapt to the changes in legislation as well as the necessity of creating an environment in which performance is properly evaluated.

In recent years, the Romanian public sector has moved from the traditional paradigm to models that meet the demands of knowledge-based economy, such as: flexibility, globalization, horizontal/vertical integration, innovative enterprises, organizational learning, customer-led strategy, electronic procurement. The new paradigms make the shift to the electronic procurement system, by creating a global collaborative and competitive network.

The present study highlights the importance of developing an agile solution for Business Intelligence (BI) and shows the stages of the solution in the case study of public procurement. The new trends in information technology and communications as well as those in the field of public procurement (legal principles, principles of quality management) have been considered in relation to achieving an agile BI solution.

The research methodology consisted in rigorous analysis of recent trends in the areas of interest, in practical documentation and in the authors' expertise in the areas of information technology (IT) and public procurement. This paper is continuing research in these fields, based on the (theoretical and practical) results, and is continuing with the steps of development of agile BI solutions.

2 Modern approaches in the development of agile Business Intelligence solutions

Developing a BI solution is an activity that involves many challenges, being constrained by the reality of information. Developers have to understand the business requirements, the format and the weaknesses of data sources, the existing systems, the various needs of the users etc. The development of the BI system has the purpose of ensuring comprehension of the factors affecting performance metrics and of providing managers with expressive representations of the information that shapes the business.

Creating a BI environment involves building an analytical data warehouse for managers. In many institutions, the most important decision metrics are calculated on the basis of information collected from various systems. For this reason, ❶ Business Process Modeling (BMP) is an important technique for gathering this information and, along with the data warehouse, is a method of integrating different sources of information.

Moreover, a data-centered approach on BI represents just a part of the picture of business. A process-oriented BI solution gives a complete picture of the business [1], providing information on data from the business process operations and the IT infrastructure, historical analyses and metrics on the history of business processes, the business plans, forecasts and budgets, data from external events in the form of key performance indicators, alerts, reports, and recommendations for corrective action.

The analysis of processes and ❷ Business Rules (BR) is necessary to further analyses for the creation of the BI solution, as the BR helps defining the dimensions and metrics. One of the key factors for the success of the development is the use of BPM and BPM/BR analysis for improving the database schema of the data warehouse. The combination between business rules and web services offers an adequate approach for applications integration and sharing of distributed information (details about main components of an e-Procurement system are presented in [2]).

❸ Service-oriented architecture (SOA) can provide numerous benefits, such as: promoting reuse, the ability to combine services to create new composite applications, use of decoupled services with a standard interface, while providing at the same time a technological method for the development of Business Intelligence solutions [3]. Implementation of ❹ Master Data Management (MDM) into SOA strategy [4] ensures data consistency, alignment of the organization's information resources, correct dissemination of information inside/outside the organization, and delivery of all the potential benefits of SOA initiatives.

Business rules adoption, together with a service-oriented architecture, allows the integration of strategic corporate applications between multiple business units. For example, the same business logic that has been explicitly defined in a Business Rules Management System (BRMS) may be shared in a Service-Oriented Architecture with other applications that need it. These applications communicate via XML with the Business Rules Services [5].

To accelerate the adoption of BI and BPM technologies, which involve relatively high costs for institutions, ❺ Cloud Computing may be used, considered to be a cheaper solution for providing intelligence and business process management ([6], [7]). Cloud computing is considered the next step in Internet evolution, providing for organizations a way to use IT services, against payment, from infrastructure and computing power, applications and business processes, to customized collaboration [8]. Given the complexity of these platforms, the agility of these solutions is difficult to test and validate.

The importance and utility of the audit of Business Intelligence solutions is measured in relation to effects on the

quality of economic activity and processes within organizations. The audit process helps us discover relatively quickly the weaknesses and the parameterisation problems of BI solutions in relation to the specific activity that is subject to implementation [9]. Thus, we can find answers to questions concerning the Business Solution solution's response times to data or information queries, the quality of data and information, how data are extracted from the system, the view mode, the user ring structure and content tree structure, the structure of data cubes and aggregation-disaggregation or synthesizing-desynthesizing queries within processes of ensuring information compatibility, etc.

Developing a BI system involves going through several steps [10], starting by identification of decision makers, of issues, entities and events that are necessary to make the decisions. Then follow the identification and analysis of business rules, the development of prototypes of BI dashboards and the underlining the cubes. In the final step of BI development process, the result will be certified. Metrics must be confirmed by management data and images. Finally, the BI system is released in order to be used by the managers.

3 Steps to develop an agile Business Intelligence solution

The further steps take into account the modern development solutions mentioned above. In addition, each step of development is exemplified in the case of procurement process within Romanian institutions.

3.1. Identifying decision-makers and defining performance metrics

In creating the department's performance evaluation system it should be taken into account the performance aspects of acquisitions, which are of interest to institutions' managers and key stakeholders, and the way in which they could be measured. The process of creating the system of indicators is built on three stages [11].

a) Identifying the overall objectives. The BI system should provide a representative picture of the objectives and of the indicators that justify them. For a purchasing function to be efficient and effective it has to ensure the three main objectives (savings, quality, convenience). One of the principles underlying the granting of a public procurement contract is the "efficient use of funds." Thus, the main function that a procurement service should provide is to ensure that funds are spent wisely, achieving savings in purchasing the goods and services required to meet the needs of the institution.

b*) Identifying key procurement processes necessary to achieve overall objectives*. To achieve the overall objectives of the department, it is necessary to ensure: compliance with best procurement practices; customer relationship management; supplier relationship management; procurement management.

c) *Identifying the necessary organizational resources*. The following elements must be present within the institution in order for the key processes to be developed: skilled human resources, resource allocation policy, and policies to stimulate employees.

The system of indicators has the purpose of encouraging progress and best practices in areas like ❶ efficiency, ❷ collaboration, ❸ compliance with the law, ❹ training, and ❺ electronic procurement. Taking into account the key performance issues identified in the three stages, the study [12] puts forward a system of indicators for the public procurement process.

3.2. Identifying the necessary information

BI for public procurement provides support to department decisions through the assessment indicators established at the

previous stage. Managers will use these metrics to evaluate the procurement performance level in the institution. Information gathered from different systems that contribute to the business model is needed to calculate these metrics. Each of the systems requires one or more processes. ETL (Extract, Transform and Load) processes will collect data for the business model.

The information necessary to calculate the performance metrics is collected mostly from of the operational source systems and, to a smaller extent, from additional source systems or manual processes. The institution has a medium level of informatization and there are several applications that administer data needed by the procurement process. The source systems that provide the most information and underlay the procurement process are: the relationship with customers, with suppliers, the accounting and the procurement system [13].

At each stage of the procurement process, users create data that can potentially be used for BI. Also, to complete the stage, users need BI. For example, to validate a request from a client, the demand must be within the limits of the available amount of money, and if it is not, the customer is offered alternative products or sources of funding. BI for procurement supports the procurement decisions through evaluation of the three metrics associated with the overall objectives of the department and through analyses that affect these metrics. Bellow is exemplified the diagram of BI concepts for calculating the savings indicator (figure 1).

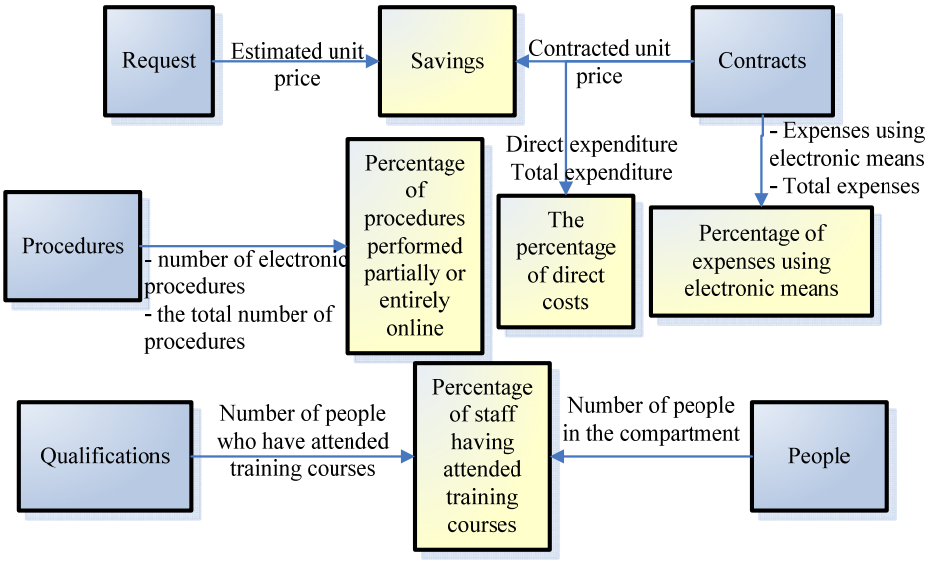

Fig. 1. Entities diagram for the calculations of savings indicator

3.3. Definition of business rules

BI experts use the term "business rule" in a variety of meanings and contexts. The definitions of this term can be focused exclusively on the business perspective or on the IT perspective. Ronald G Ross provides a description of the business rule that encompasses both sides. From a business perspective, the "business rules are literally the encoded knowledge of your business practices", while from the IT perspective, "the business rule is an atomic piece of reusable business logic."[1]

From the IT perspective, business rules are coded in certain cases in data warehouse ETL processes or in BI instruments, during the design of the specific reports. These are not the optimal choices for the integration of business rules. An optimal method for

[1] Ronald G. Ross. *Principles of the Business Rule Approach.* Boston: Addison-Wesley, 2003.

achieving business logic is independent description of rules in a separate module. This software component is dedicated only to the implementation of business logic and has four major advantages [14]:

- it is well designed and the business logic module can be transparent for business users;
- allows adapting business rules to the frequent changes;
- reduces duplication (if the IT department decides to replace an ETL or BI instrument, the implementation of rules does not change);
- allows interfunctionality, widely use of IT and business rules management.

Combining business rules and Web services provides an appropriate approach for integrating the application and sharing the distributed information. The adoption of business rules, along with implementing a service-oriented architecture allows the integration of institution's strategic applications between multiple business units. For example, the same business logic, which was explicitly defined by BRMS may be shared within SOA with other applications that need it. These applications communicate via XML with the Business Rules Service [5].

In this step: ❶ the rules affecting the modeled metrics should be identified, ❷ the rule for the limit values and their incorporation as dimensions within the warehouse data should be analyzed, ❸ numerical calculations should be extracted and added as facts in the data warehouse. Building a BI system according to these considerations will help managers to assess the effects of changes in the limit values and calculations. As all rules are centralized, it will be easy to find a rule and to use it in evaluating decisions.

Each defined business rule should classify, calculate, compare and control [10]. Thus, the business rule: • should classify the type, the division or the range (for example, suppliers may be classified as: approved, indifferent or unauthorized; the types of requests may be grouped into: approved, rejected, pending or completed); • should calculate formulas, should query data and statistics, transform and associate values (there are often numeric constraints - for example, applications must be within a client's maximum budget available, a conversion rule converts input values into useful data); • should compare the result with the limit values (the limit value is the key-value that must be met or must not be exceeded, or that is within a certain range), • should control what is true or valid, right or wrong and the associated messages (business rule example in [12]).

3.4. Defining business processes

Inclusion of time and performance into the data warehouse imposes the need to identify the processes associated with procurement, to find the time records for the steps and to incorporate changes in the time and date into the data warehouse. In order to define the business process we will use BPMN with SOA, which will provide many benefits. Separating the business in a number of central and discrete processes, an institution may provide a certain service to its customers or it may outsource the service. Control of business processes is done using business rules.

The BPM design software coordinates the details and activities, while execution environment invokes them at the right time. Because the BPM software coordinates the activity, the approach on business processes simplifies the creation of applications. The programming team writes the code which carries out the activities and the BPM software coordinates these activities. The flow controls connect the design details and become process activities. Then follow the identification of data or of business entities for the business processes. For important interfaces and business processes, business rules will be added to the diagram. Within a process, the rules may define policies, constraints or competitive business practices. The final step of the business

process is to define exceptions and points of failure. The result of the business process design is a prototype of the work process which, corroborated with interfaces, and confirms business entities.

Developing the main business processes

The central business processes, which are necessary to procurement activities, are the following: the issuing of the request, the approval of the request, the acquisition, and the completion of the request. These processes are independent from the systems that develop them; they execute an activity within the business architecture. Processes use the application as a service that moves transactions or adds a procedure in a system queue. Main business processes operate through data processing. BPM substantiate traditional business data with descriptive process information, mainly information related to activity time. Addressing the main business processes is an important modeling technique, essential in the construction of SOA. Monitoring of procurement procedures will be simplified. Thus, by using a process-oriented approach, the executive board will monitor high-level business processes, while managers will measure and control the subprocesses [13].

The process of issuing a request

For the purpose of customer relationship management, more specifically for the management of client requests, it may be used a combination between a web model and an internet shopping card (figure 2). Customers can view listed all the products proposed by the system and can add a product in their shopping cart (figure 3). Searching is done by locating a particular product or set of products based on several criteria: keyword, category (subcategory) of products, accounting record, storage identification number, etc. Customers are offered the facility to select multiple products and compare them based on a common set of criteria.

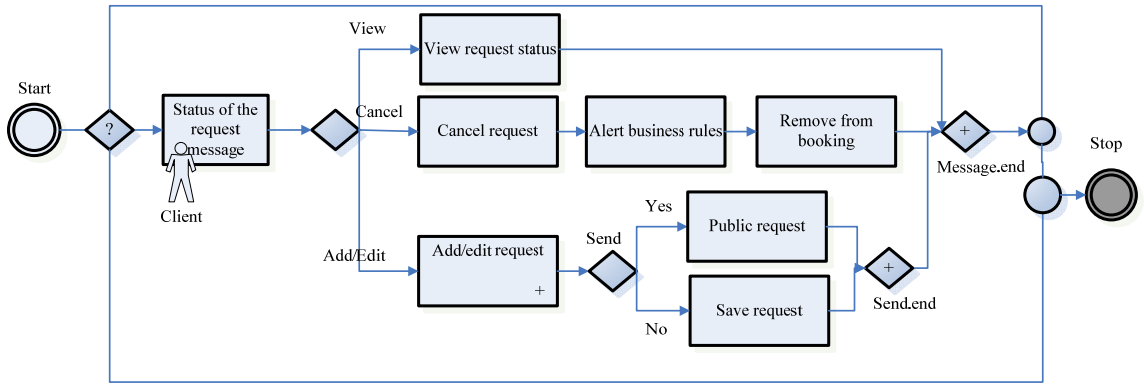

Fig. 2. Business process diagram for issuing the request

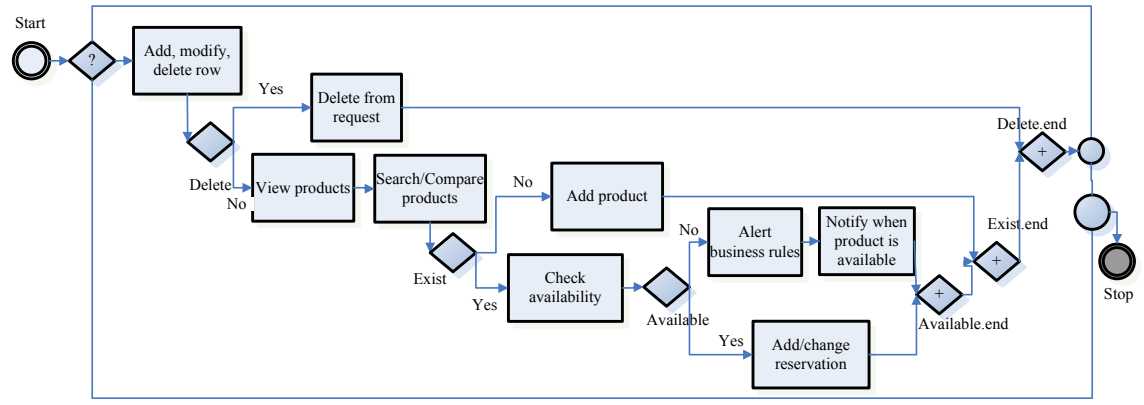

Fig. 3. Business process diagram describing the "Add/edit request" subprocess

Customers can add, within the request, a product that is not present in the list. In this case, the minimum information necessary in order to add the product is: the name of the product, the estimated unit price in lei, VAT excluded, and the minimum specifications required. For products that are not readily available to customers, the system will ask if they want to be notified via e-mail when the product becomes available. For each request shall be specified the necessary acquisition date and the place of delivery.

The system will allow customers to view the content of purchase requests and to add, change or delete a product from this content. The requests recorded and accepted by the system may be accessed and viewed for later use. At any time, the client can view the status of the request within the system. A customer who wishes to delete a request can do so only if the business rules acceptability conditions are met.

The process of approving a request

The system automatically determines the level of approval of a request, depending on the total value and the source of funding, according to a business rule, and notifies the approving manager on the existence of the request (figure 4). The manager is given the opportunity to view, select and examine the details of a request, in view of approval, modification or rejection. A request will be marked as a purchase request only after all the business rules are applied. The system automatically makes a log of requests and offers the option for issuing reports, according to selection criteria.

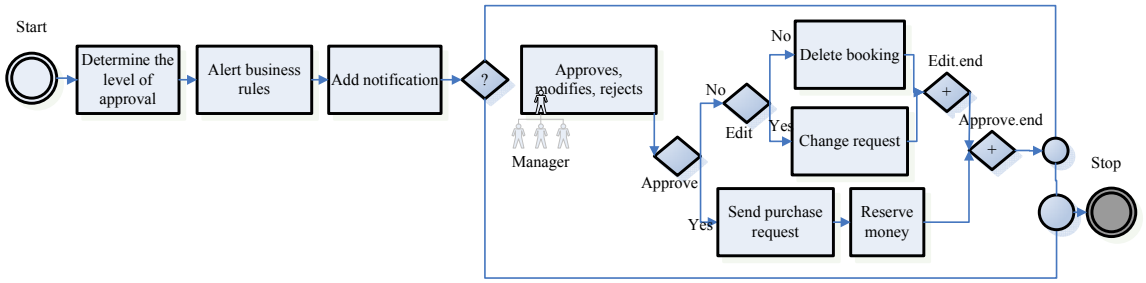

Fig. 4. The business process diagram describing the approval process

Processing the request

When a purchase request enters the system, it will be associated with a purchaser, depending on the type of contract, the category of products, its load factor, according to a business rule (figure 5). The purchaser may classify the products from the request (if they are available), may associate the request to an existing procurement procedure (for centralizing the information) or start a new procedure, according to business rules.

Starting a procurement procedure requires issuing all the necessary documents and their marking as approved only after the proposed sums are recorded and validated in the accounts associated to the requests (figure 6). Then follows the creation of tender documentation based on specifications and data from the associated requests, according to forms required by the law and by their transmission over the HTTP protocol. The acquisition system will submit for publication in SEAP (Electronic System for Public Procurement) the procurement documents needed for publication.

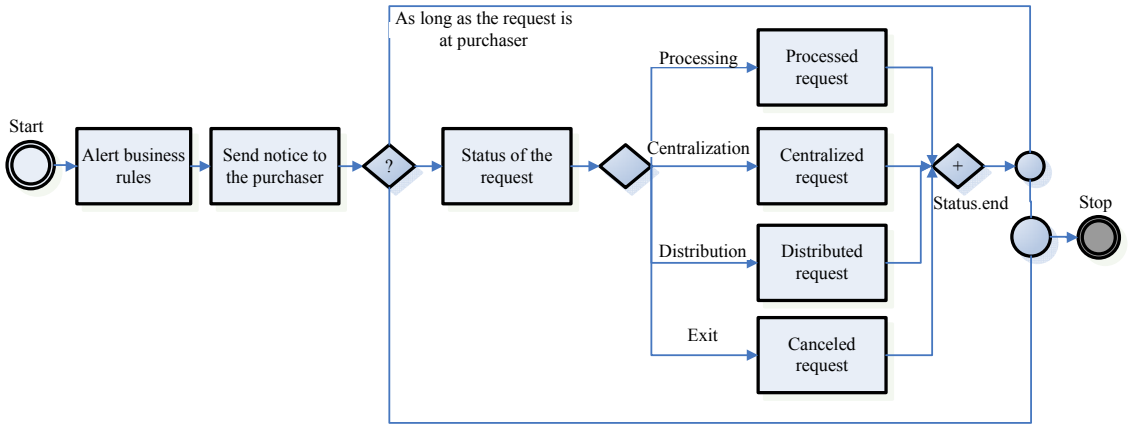

Fig. 5. The business process diagram describing the procurement process

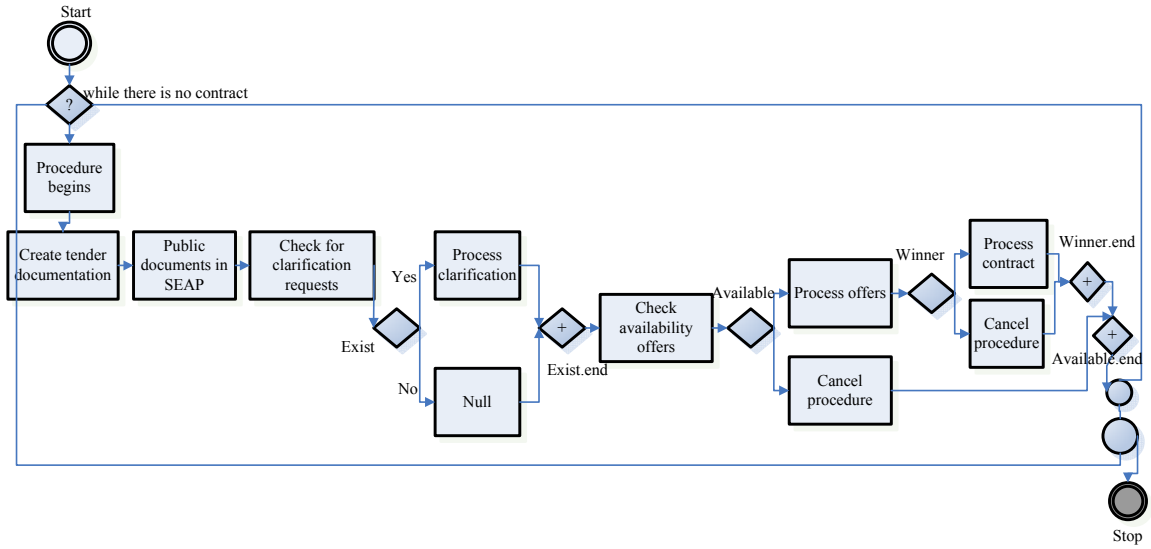

Fig. 6. The business process diagram, describes the "request under processing" subprocess

Information on the offers will be taken from SEAP, in the case of online procedures, or manually entered by the purchaser, in the case of an offline procedure or of a combination of offline and online procedures. The processing of offers follows next, involving the issuing of the evaluation documents according to forms required by the laws and to certain business rules, the announcing of the outcome of the procedure and the solution to possible disputes.

The procedure can be finalized by cancellation or the closing of one or more contracts and their registration into the system. On the basis of the contract and business rules, the contracting authority shall issue the firm orders to the supplier. The system automatically creates a log of procedures and allows the creation of reports listing all acquisition procedures, according to the selection criteria.

The process of completing the request

After inspecting the contracting authority, the accepted products are automatically added to the inventory management system through a unique identifier assigned to each product via a barcode reader (figure 7). If defective products are identified, they are returned to the supplier for correction or replacement. Products payment will be made by transferring the money from the clients' accounts to the account of the provider. The central deposit or the distribution centre delivers the actual products to the customer site and receives a delivery confirmation. The reception of the product by the customer, at the central deposit or at the distribution centre, represents the completion of the

acquisition process. The system creates the log of reception and enables the creation of reports listing all suppliers / products received from suppliers, according to certain criteria.

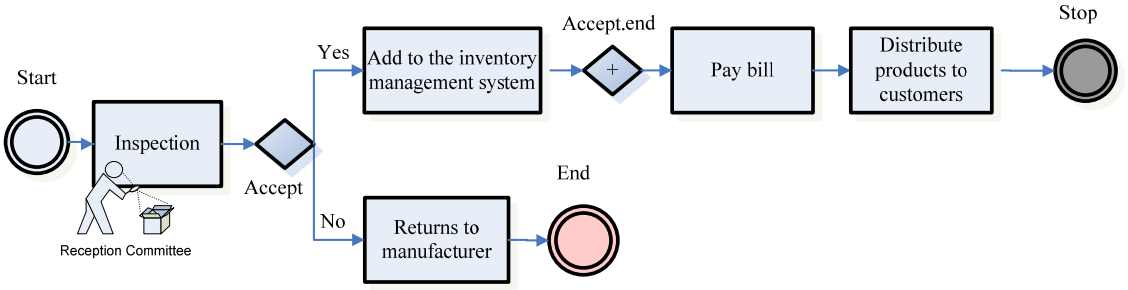

Fig. 7. The business process diagram for the process of completing the request

Flow control elements

BMNP instruments create a single document for each of the processes. BPMN coordinates services and applications through the link with the Web services, concentrating all logic on constructing a composite application that would be easily modifiable.

Data elements

In order to achieve a concise analysis, the data concept diagrams for the processes of issuing (figure 8), approval (figure 9), acquisition (figure 10) and completion of a request (figure 11) will not contain the attributes of entities. The concept describes the data design carried out during a BPM design process.

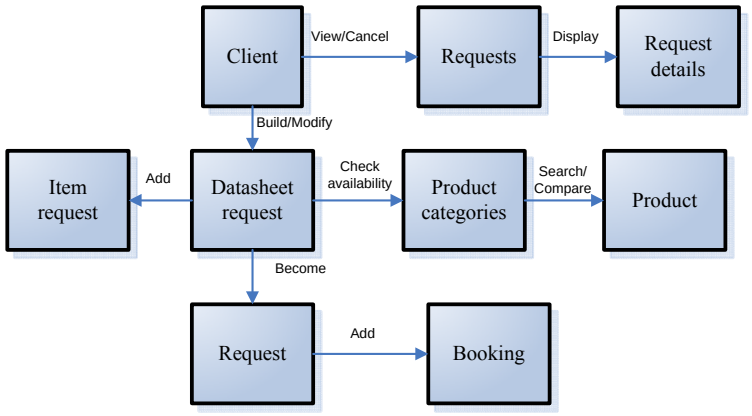

Fig. 8. The process of creating a request uses entities from different systems in order to manage customer requests

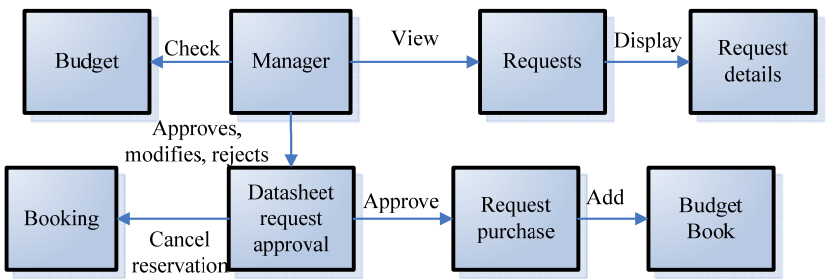

Fig. 9. The process of approving a request uses entities from different systems in order to manage the approved requests

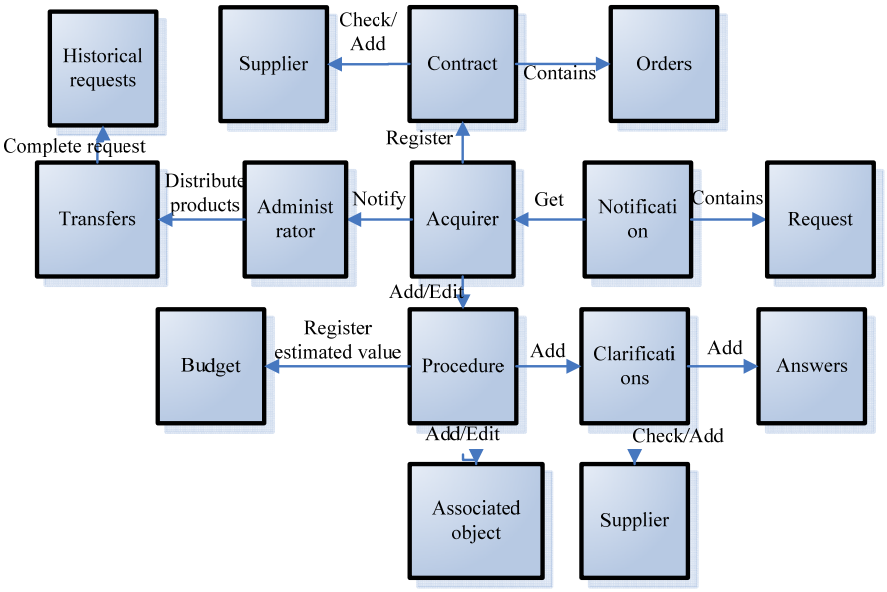

Fig. 10. The process of acquisition uses entities from different systems in order to manage the acquisition procedures

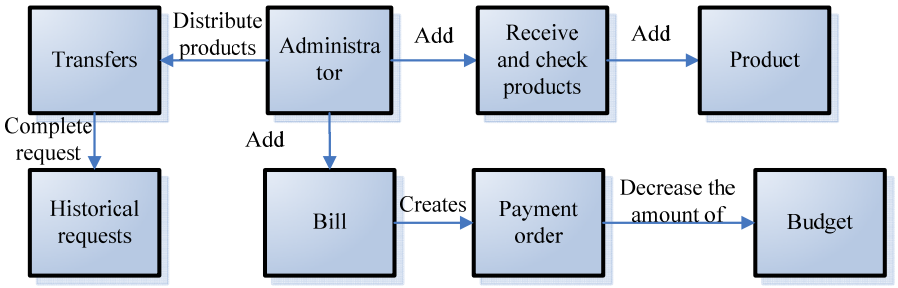

Fig. 11. The process of completing a request uses entities from different systems in order to manage the products

Establishing business rules of business processes

BPMN uses web services to invoke subprocesses, business rules and to interface with external systems. In the business processes only the data structure is needed to invoke a web service. An XML WSDL specifies the web service.

The following business rules are presented for the process of issuing a request:

- a business rule deciding whether the client will make an e-mail or phone notification when the requested object is close to the address of destination;
- a business rule deciding whether a request sent by the client may or may not be revoked / changed.

Procurement solution interfaces.

After detailing the central business processes, the project team has to design the interfaces. BPM / BR must ensure the link between current networks, business systems and existing applications into a single IT system – a composite application. Once the needs of the interface are established, the business forms or data entities have to be mapped according to the needs of the external systems. This task involves creating a series of process activities mapping the attributes of business forms according to systems interfaces.

Connecting the organization with external suppliers involves the use of open protocols, such as business protocols EDI (Electronic Data Interchanges) or B2B (Business to Business). At the time of execution the business process will register all the steps, from the first reception of a message until the final transmission of the message to/from the supplier.

Programming processes. BPM instruments provide integrated control and programming solutions for all business processes. In general, BPM solutions provide a control instrument that centralizes all businesses processes and the requirements of data processing within a simple application that is consistent and easy to manage.

Exceptions. To complete the business process the diagram must be detailed to include exceptions and the appropriate message structures. The system must be able to handle exceptions and allow transactions to return to original state.

3.5. Business Intelligence Dashboard

Design of the executive dashboard is made by controls based on measurements or dimensions. Using different combinations of visualisations and controls, the BI team must create a dashboard providing a view on the features of the business monitoring environment. Taking into account the need to underline indicators reflecting the different levels of aggregation, we will present different examples, using the dimension-based development. When the historical value is above or below the basic value, managers need to discover the performance characteristics. At this stage the “slice and dice” technique is used to break the cubes. Managers select the dimensions within the dashboard, and then choose the metrics to be calculated by the dashboard.

In designing the scheme of the data warehouse, the following types of schemes may be used: the "star" scheme, the "snowflake" scheme and the "constellation of facts." Given the fact that the "star" scheme provides a direct and intuitive link between the business entities and the performance of queries, we will use this type of scheme.

Based on the metrics identified in step one, we provide the example of the savings cube in the area of public procurement. All public institutions must measure the value of savings over a period of time in relation to the procurement procedure, the purchaser and the institution. This information is useful to managers in making timely decisions to reinvest or in the policy of providing incentives for purchasers. In order to calculate the *savings* indicator the following dimensions are taken into account: the time, organized by trimesters; the procedure, according to the similar products; the purchaser, the person responsible with the procedure (figure 12). Facts from the savings data warehouse include the estimated unit price, the contracted unit price and the quantity.

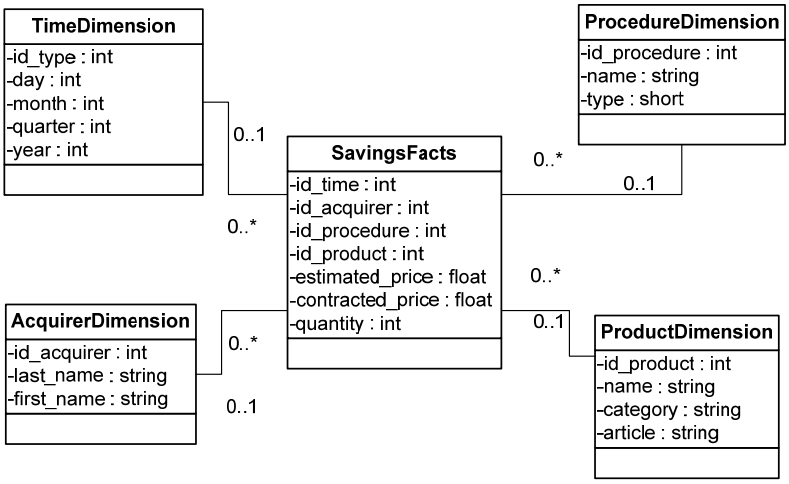

Fig. 12. Dimensional model for savings

3.6. Identifying ETL processes, testing and publishing

On the basis of the identified dimensions and measures, the ETL programs / software have to populate the data warehouse with information from the identified source entities. ETL is best done using business process techniques, because most ETL programs automatically decide when to insert or modify records. ETL processes for data collection may be: • iterative extractions of operational data, loading of a file, • data query by JDBC or *middleware*; • messages from a different business process.

4 Conclusions

Organizations are encouraged to become service-oriented and integrate agile and intelligent solutions that lead to increased efficiency and innovation. Integration of intelligent solutions depends on the outcome analysis of costs and benefits of Business Intelligence solutions and resources available for implementation. Also, the possibility of using a traditional Business Intelligence versus Cloud Computing solutions need to be considered.

5 Acknowledgment

This work was supported by CNCSIS-UEFISCSU, project PN II-RU (PD), "Modern Approaches in Business Intelligence Systems Development for Services Oriented Organizations Management", code 654/2010, contract no. 12/03.08.2010.

References

[1] M. Mircea, B. Ghilic-Micu and M. Stoica, "Combining Knowledge, Process and Business Intelligence to Delivering Agility in Collaborative Environment". L. Fischer, ed. 2010. *2010 BPM and Workflow Handbook, Spotlight on Business Intelligence*. Florida*:* Future Strategies Inc. & Workflow Management Coalition, pp.99-114.

[2] M. Stoica, B. Ghilic-Micu and M. Mircea, „Electronic biddings for public acquisitions of goods, services and work: Romanian approach". In: *The 9th WSEAS Int. Conf. On Mathematics and Computers in Business \and Economics (MCBE'08)*, WSEAS Press, Bucharest, Romania, ppg. 62-67, 2008;

[3] M. Mircea and A. I. Andreescu, "Agile Systems Development for the Management of Service Oriented Organizations". In: *11th International Conference on Computer Systems and Technologies, CompSysTech'10*, Sofia, Bulgaria, 17-18 June 2010, pp. 341-346;

[4] A. Andreescu and M. Mircea, "Actual Trends in Software Systems for Business Management", *CompSysTech'08, The Bulgarian*

Academic Society of Computer Systems and Information Technologies, 2008;

[5] G. Holden, "Reactive and Proactive Business Intelligence", 2007, http://www.b-eye-network.co.uk/view-articles/5899

[6] M. Mircea, B. Ghilic-Micu and M. Stoica, "Combining Business Intelligence with Cloud Computing to Delivery Agility in Actual Economy", *Journal of Economic Computation and Economic Cybernetics Studies*, 45 (1), 2011, pp. 39-54;

[7] M. Mircea and A. I. Andreescu, „Extending SOA to Cloud Computing in Higher Education". In: K. S. Soliman (ed.), *The 15th IBIMA conference on Knowledge Management and Innovation: A Business Competitive Edge Perspective*, Cairo, Egypt 6-7 November 2010, pp. 602-615,;

[8] M. Cunningham, "Cloud Computing Enables Self-serve BI", 2010, http://www.dashboardinsight.com/articles/business-performance-management/cloud-computing-enables-self-serve-bi.aspx

[9] B. Ghilic-Micu, M. Mircea and M. Stoica, "The Audit of Business Intelligence Solutions", *Informatica Economica*, 14 (1), 2010, pp. 66-77;

[10] T. Debevoise, *Business Process Management, witch a business rules approach, Implementing the Service Oriented Architecture*, United State of America, Tipping Point Solutions, 2007;

[11] B. Ghilic-Micu, M. Stoica and M. Mircea, Management of Acquisitions in Romanian Public Institutions. In: *Calitatea-acces la succes*, 93, Societatea Română pentru Asigurarea Calităţii, pp. 344-350, 2008;

[12] M. Mircea and A. Andreescu, "Using Business Rules in Business Intelligence", *Journal of Applied Quantitative Methods*, vol. 4, pp. 382-393, 2009;

[13] M. Mircea, "Development of Business Intelligence system for public acquisitions", ASE Printing House, pp. 427-432, 2009, In: *The Proceedings of the Ninth International Conference on Informatics in Economy*, may 2009;

[14] R. Blasum, "Business Rules and Business Intelligence", *DM Review Magazine*, April 2007, http://www.dmreview.com/issues/20070401/1079638-1.html

Marinela Mircea received her degree on Informatics in Economy from the Academy of Economic Studies, Bucharest in 2003 and his doctoral degree in economics in 2009. Since 2003 she is teaching in Academy of Economic Studies from Bucharest, at Informatics in Economy Department. Her work focuses on the programming, information system, business management and Business Intelligence. She published over 35 articles in journals and magazines in computer science, informatics and business management fields, over 15 papers presented at national and international conferences, symposiums and workshops and she was member over 15 research projects. She is the author of one book and she is coauthor of three books. In February 2009, she finished the doctoral stage, and her PhD thesis has the title *Business management in digital economy*.

Anca Ioana Andreescu is university lecturer in Economic Informatics Department, Academy of Economic Studies of Bucharest. She published over 20 articles in journals and magazines in computer science, informatics and business management fields, over 20 papers presented at national and international conferences, symposiums and workshops and she was member in over twelve research projects. In January 2009, she finished the doctoral stage, the title of her PhD thesis being: *The Development of Software Systems for eBusiness Management*. She is the author of one book and she is coauthor of four books. Her interest domains related to computer science are: business rules approaches, requirements engineering and software development methodologies.