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An Agile Architecture Framework that Leverages the Strengths of Business Intelligence, Decision Management and Service Orientation

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1. Introduction

In nowadays economy, the tendency of any enterprise is to become an intelligent one and through new and innovative strategies of business intelligence (BI) obtain a competitive advantage on the market. At the same time, the collaborative environment involves the need for modern solutions to cope with the complex interactions between participants and the frequently changing market. In these circumstances, enterprises tend to go beyond agility and achieve a dynamic vision on demand. In a narrow sense, the agility incorporates ideas of flexibility, balance, adaptability and coordination. The enterprise agility may be considered the ability of the enterprise to adapt rapidly and to cost efficiently in response to changes in its operating environments (Wang & Lee, 2011; Dove, 2001). The *intelligent enterprise* is the learning enterprise where the capability to continuously adapt to changes and unpredictable environments is developed (Brătianu et al., 2006). In addition to the previous definition, we shall consider the intelligent enterprise as having a *lean, agile and learning enterprise knowledge infrastructure* as driver for sustainable competitive advantage. According to the Gartner Group, the agile enterprise must be "Real-time, service-oriented and event-controlled" (Vickoff, 2007).

Thus, within enterprises the need for proactive, challenging instruments appeared having a strong impact when compared with conventional reports, dashboards, analyses carried out by OLAP (On Line Analytical Processing) systems and this aspect may be noticed at the business intelligence suppliers. Due to the industry changes, the year 2007 marked the beginning of a new business intelligence era, proactive, extensible and performance-oriented. This new era may be viewed as a new perspective where business intelligence is combined with the management of business processes, business rules engine, decision management systems, service-oriented architecture and other instruments and techniques directly/indirectly and immediately applied to the decisions of the business. The new BI era is characterized by the following aspects:

- integrates the information within the decisional processes through decision services;
- ties business processes with business rules which may be changed any time;

- integrates the business intelligence benefits with the capabilities offered by the team, collaboration and management of business processes.

In the last stage of evolution, business intelligence can be seen as a service fully integrated with processes, applications, marketing strategies of the organization, able to solve business problems and capitalize on market opportunities. As an integrated service, business intelligence becomes from monolithic system, a flexible service, agile, able to adapt quickly to the demands and market changes. To reach the last stage of business intelligence maturity, suppliers must provide end to end platform to support the service requirements of business intelligence. Thus, suppliers should focus on the latest technologies and tools to solve problems faced and the opportunities in the market. Identification and analysis capabilities of the platform, highlighting the differences between emerging technologies capable to solve the same type of problems, highlighting trends are needs in the development of agile business intelligence platform.

A service-oriented architecture (SOA) can provide numerous benefits such as promoting reuse, the ability to combine services to create composite applications, while providing a conduit for developing technology solutions for business intelligence. Implementing master data management (MDM) ensures consistency of data in SOA strategy, aligning the organization information resources, correct dissemination of information inside/outside the organization, ensuring delivery of all the potential benefits of SOA initiatives. Complex event processing (CEP) is a technology based on rules that groups real-time information systems, databases and distributed applications to provide benefits business intelligence solution. Each organization acts as a set of rules, business rules (BR), which may be external rules (regulations in force that can be seen in all organizations operating in a particular area) and internal rules (which define the business policies of organization whose purpose).

The combination of BI, SOA, MDM, BR and CEP enables organizations to be connected in real time at each level, to process daily activities and strategic decisions. Also, in the context of a recession, the combination of cloud computing technology offers new ways and BI analytical data management and business possibilities. Cloud computing streamline BI offering hardware, networking, security and software necessary to create data on demand deposits and different approaches to pricing and licensing use. Currently, there are still issues of how to combine these technologies to provide the ability to identify and implement new solutions that take advantage of accurate real time data about products, customers and suppliers to ensure organization and coordination and proper use of information within the organization to achieve business objectives and gaining competitive advantage.

Business intelligence evolved from a data-oriented to a process-oriented model allowing for optimization of business processes based on near real-time, actionable information. Process-oriented BI combines business process management (BPM) and business intelligence (Jandi, 2008, as cited in Mircea et al., 2010) and is subordinated to upper management. It provides the input data for business decisions that execute the organization's strategy, improve performance and in the end give the best results (Ventana, 2006), applying intelligence into practice. The process-oriented BI is implemented in the entire organization, being used in business planning and in business development (tactic and operational BI) and providing information for strategic, tactic and operational decisions. At the same time, the output offered by business intelligence represent inputs for grounding the decisions related to BPM processes. The combination between BPM and BI provides many benefits, leading to

simplified, efficient and agile processes, but it does not automate the decisional process, which represents an essential element to be taken into consideration in obtaining enterprise agility.

At present, the organizational expansion and the complex business environment determines the decision process to be confronted with at least the following challenges (Yu & Zheng, 2011): the complexity increase of the decisional environment, the need for some dynamically changed decisions, taking decisions based on heterogeneous and distributed decisional resources. Also, the decisional process usually takes a long time to reach a final decision (thus there is a gap between the time the information is received and the time the decision is made). Under these conditions, arises the need for a decision management (DM) solution, that extends the capabilities of existing technological solutions (for example BI, BPM, SOA) at least in these directions (FICO, 2009): ❶ gives business users control to increase agility, ❷ helps organizations make decisions in the face of uncertainty, ❸ drive out costs and ensure optimal resource allocation in the business, maximizing the return they make on their assets, ❹ helps organizations improve customer treatment everywhere.

For the success of the implementation, it is essential that the decision management to be performed using modern technologies/solutions of decision automation and optimization. It is also important that the management of these decisions to be performed alongside processes and not by using business process management. The service-oriented approach allows the automation, management and reuse of decisions as decision services in SOA. Service-oriented architecture permits the maximization of the decision's reuse, the reduction of time in taking decisions and the increase of return of investment. Moreover, service-oriented architecture facilitates the data management expansion within the entire organization. Thus, decision management becomes enterprise decision management (EDM). According to recent researches, decision management offers the biggest value when applied within the entire organization.

The objective entails development of an agile architecture framework that leverages the strengths of business intelligence, decision management and service orientation that should support solving integration problems, complex interactions between business partners and gain enterprise agility. In order to attain the agility goal we will look at three fundamental elements: data, processes and decisions. Achieving this desiderate implies knowledge on the meaning of business intelligence, business process management, decision management and service-oriented architecture, as well as understanding the connection between them.

2. Combining business intelligence with decision management

In the business context of today, characterized by high complexity and uncertainty, making the right decisions is an important process and, usually, difficult one. Even more, using collaborative solutions, based on internet and the apparition of new types of organizations (virtual organizations) changes every aspect of the business (structure, culture, processes). The new generation of business requires collaborative decisions and a new management style (Tapscott & Tapscott, 2010). The lack of adequate technological solutions to support the decisional process may lead to disastrous effects, especially for financial institutions (banks, insurance, credit, investment companies).

Over the time, business intelligence solutions were developed to help managers solve decision problems, by providing them with an analysis of a large amount of data – especially for the higher levels of the hierarchy. These solutions improve various aspects of

decision making, literature dividing them into 1. strategic BI, 2. tactical BI, 3. operational BI, and 4. pervasive BI. They are designed for different categories of users, helping them make strategic, tactical and operational decisions. All four types leave the actual decision making outside the business intelligence system, where the main factors are user experience, organization rules and policy and system information.

During the recent years, organizations shifted their focus from strategic decisions (few, but with high economic impact) towards operational decisions (many, with low economic impact). In (Media, n.d.) the importance of operational decisions is highlighted as their large number compensated for the small effect, adding up or exceeding the effect of strategic decisions. Operational decisions are considered critical and the lack of ability to make them may reduce the organization's chances for success. In order to improve the operational decisions, operational or pervasive business intelligence solutions may be used. Pervasive business intelligence ensures the implementation of technologies, organizational culture and business processes aiming to improve the stakeholders' ability to make operational and strategic decisions (IDC, 2008). The decisions situated at the level of process unit (operational decisions) are the front line in driving business agility.

The automation of operational decisions can be performed by using decision management systems. They allow the identification of operational decisions, their automation, the separation and storage of decisions into a central repository. The need for automated decisions lead to the use of decision management systems that integrate policies, procedures, business rules and the best practices into making the best decisions. Decision management systems focus on the decisional process, allowing agile, precise, consistent and fast decisions with low cost.

The change in the business structure, due to collaborative environment, leads to changes in the decisional system like: more decision makers, transparency and opening (Tapscott & Tapscott, 2010). A collaborative decision management solution (CDM) fits very well to this context. Gartner Research calls this "a green field market as far as software is concerned". Table 1 (Taylor, 2009) presents various aspects of business intelligence solutions and decision management solution. Additionally, we present aspects the decision management solution in a collaborative environment (CDM).

Solution / Aspect	Strategic BI	Tactical BI	Operational BI	Pervasive BI	Decision Management	Collaborative Decision Management
Goal	Long-term planning	Manage line of business	Improve daily operations	Improve daily operations	Improve daily operations	Improve daily operations
Users	Executives, analysts	Line of business managers	Operational managers	Front-line staff	Front-line systems	Knowledge workers, and front-line systems
Response Time	Days	Hours	Minutes	Seconds	Sub-second	Faster, real time
Analysis	Long-term trends and patterns	Tracking against KPIs, investigation	Exception or problem handling	Summaries, some trending	Patterns, predictions, scoring	Technically-sophisticated analysis, sharing of experience
Decision Making	Manual	Mix of manualy and guided	Guided	None	Automated	Decentralized and optimized
Interface	Reports and documents	BI tools & applications	Dashboards	Code or BPM environment	Decision service	Decision portals
Timeliness	Weekly	Daily	Intra-day	Continuous	As needed	As needed

Table 1. A summary of different aspects of BI and decision management (Adapted from Taylor, 2009)

The importance and benefits of using a decision management solution was recognized by multiple specialists in this field. A recent study by International Data Corporation (IDC) called "Worldwide Decision management Software 2010-2014: A Fast-Growing Opportunity to Drive the Intelligent Economy" highlights three important factors of decision making process (the flow of data, faster cycle times and the adoption of analytics) and provides a systematic approach to the process of decision making across the organization (Vesset et. al., 2010). Also, the study shows that the need to increase the visibility between intra- and inter-organizational business processes will lead to the acceleration of the adoption and use of decision management solutions.

As for the use of collaborative decision management solutions, they proved their utility and benefits in various fields. A successful example is the use of collaborative decision management in air transport. British Airport Authority has chosen Pegasystems' SmartBPM platform to support Airport - Collaborative Decision Making at London Heathrow Airport (Pega, 2010). The collaborative decision making program, a concept developed by Eurocontrol – the European Air Traffic Control agency – is designed to improve the overall efficiency of operations at an airport and create a coordinated Europe-wide air traffic management system, encompassing both en route and airport operations. Also, T-Systems developed the Total Airport Management System, a modular, collaborative decision management solution which is already being used at more than 50 airports around the world (T-systems, 2010).

Currently, the rate of use of a business intelligence/analytics solution varies greatly across sectors of activity. According to a study carried out by IDC on 2271 IT managers in 2010, the adoption rate varies between 87% (the highest) in the securities and investments industry to 52% (the lowest) in education (Morris, 2010).

The combination of decision management solutions, business intelligence solutions and other technologies improves the processes, making them more responsive, more intelligent and more automated. Decision management is a subset of enterprise architecture that improves the decision making process using business rules management system (BRMS), business process management systems, business intelligence for analytics and other tools. Table 2 presents some of the main benefits brought by automation and decision improvement, as well as the technologies used.

Decision management systems create a link between historical data provided by business intelligence and foreseen results in order to make the best decision. Used together, the two solutions provide decision makers with required information about the business processes and support for automation and decision making. Enterprise data management may be considered the link from business intelligence to *intelligent business*. The adoption of enterprise decision management provides superior facilities to the business intelligence instruments through the use of new technologies like data mining and predictive analytics technologies. Also, enterprise decision management and business intelligence complete each other regarding the focus on the three decision categories. Enterprise decision management is oriented on the operational decisions, business intelligence is oriented on strategic decision and the combination of the two provides support for tactical decisions. Figure 1 depicts the complementarity and the benefits of business intelligence, business process management system (BPMS) and business rules management system (BRMS) (as support for decision automation).

Decision Management Areas	Description	Technologies
Situational awareness and decision execution	Ability to identify events that take place in the system and react to them by providing precise and robust decisions.	Business rule management system, business event processing
Analytics	Analytics features that may be used for decision improvement and execution.	Predictive analytic, neural networks, performance management, data mining
Monitoring, reporting and optimization	Ability to provide decision support to the management personnel and systems, based on historical data and current data, through a process of optimization and simulation.	Business activity monitoring, dashboards, data warehousing, optimization, simulation
Process management – operational decision	Improvement of process agility by providing the best solution from a variety of operational decision and reuse of decision logic across processes and systems.	Business process management, business rules management, decision management, business intelligence for analytics
Intelligence	Integration of intelligence in operational processes/systems, which allows prognosis and optimization in order to identify and perform the ideal action.	Business process management, decision management and BI tools
Precision, optimization, opportunity	Improvement of precision through analyses of historical data and creation of prediction and optimization models that help make the right decision.	Predictive analytic, dashboards, data warehousing, optimization, simulation

Table 2. Some benefits of decision automation and improvement

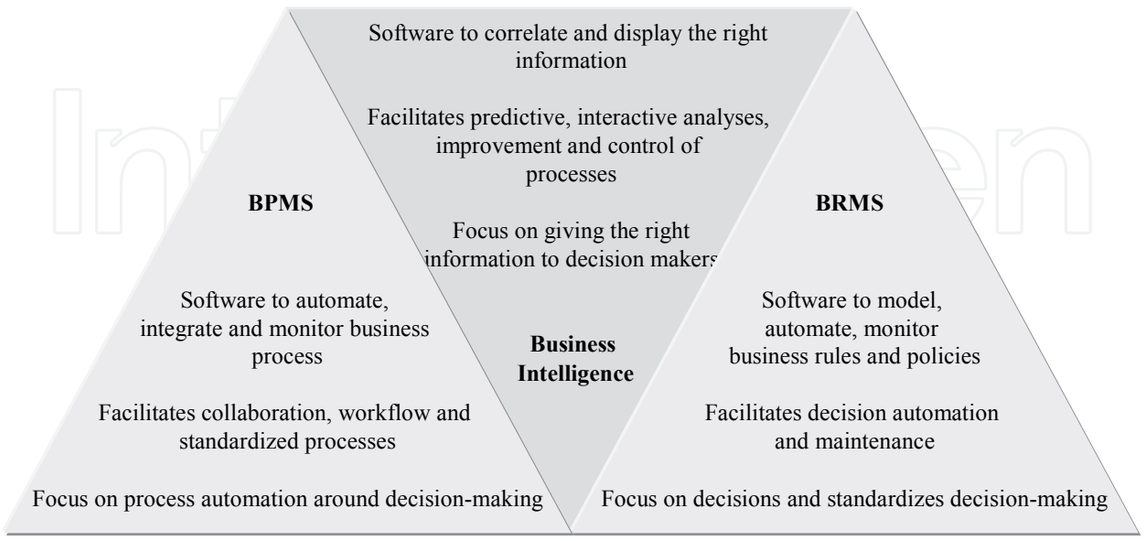

Fig. 1. Intelligent decisions from end to end

Business intelligence solutions may be used directly by the decision makers as support (guide, information provider) for decision making or indirectly by specialists as functions in the decision management. In the second case, the decision makers will interact with the decision management solution where they will define the problem and then the decision management will use the business intelligence for research and to present the results to the users. The specialists involved in various actions during the enterprise decision management chain (figure 2) can be: data analysts (for analytic models of the historical data provided by business intelligence), portfolio analysts (for optimization of strategy, based on the models created by data analysts and data about the new opportunities provided by business intelligence) and business experts that monitor and execute the business rules. Business rules management systems allow for automation of decision making based on business intelligence metrics and may take direct control of operational systems. The use of business rules management and business intelligence will ensure the support for the improvement of correctness, consistency, speed and automation of complex decisions that are facing enterprise decision management systems.

In a collaborative environment, enterprise decision management solutions must provide a few key additional features like: the decision is made by a group of decision makers from the same organization or multiple organizations; transparency of the decision making process, recording of the decision making process and self-learning; existence of collaborative decision support systems or technologies that allow the decision makers to take part in the collaborative decision making process.

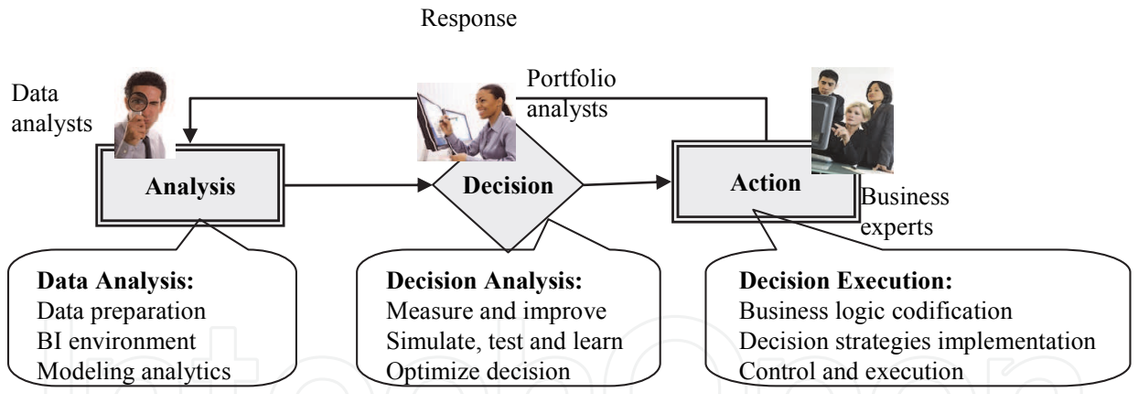

Fig. 2. The enterprise decision management chain

Combined use of business intelligence and enterprise decision management must not be seen only as potential benefits for the organization. The organization is faced with a series of problems and challenges (for example enterprise decision management interoperability with external systems) that require additional approaches / solutions. Considering this, we will look upon the analyses of service-oriented architecture, which is nowadays recognized as having benefits in solving interoperability and adaptability issues. Without service-oriented architecture, the use of enterprise decision management approach includes the decisions in applications and aligns them to a single operational system or function of the business. This leads to lack of scalability, flexibility and analytic components focused on decision.

3. Extending capabilities of existing systems with service-oriented architecture

Service oriented architecture is recognized in the literature by numerous specialists as the best solution for achieving organization agility. Still, beside the benefits, service-oriented architecture leads to a high complexity. Thus, service-oriented architecture must not be seen as a purpose, but rather analyze the opportunity of using it in the organization strategy. Combining service-oriented architecture with existing systems (for example BI, EDM, BPM) may solve integration problems for the many organizations that are still thriving to achieve it.

Even more, in a collaborative environment, due to cultural and linguistic heterogeneity, varied technological and business development of the organizations, designing solutions for informational systems interoperability remains a complex problem. Also, traditional organizations are affected by (Zeng et al., 2009): 1. weak consistency of organization strategies, business processes and technological systems and infrastructure, 2. inflexible and inexact implementation of business processes in the applications systems, 3. existence of large heterogeneity across organization systems and weak adaptability of information architecture, 4. lack of performance analyses and optimization applications for organization networks.

In a collaborative environment technological solutions must allow the integration of systems, business partners and business users and answer to external events (system events and transactions) and internal events (generated by agents and internal systems) that generate frequent changes in the organization (Mircea et al., 2010). As answer to these challenges, the instruments trend (for example event driven BPM, event based BI) is to provide collaborative capabilities (for example process discovery, modeling and optimization) and dynamic capabilities (for example: dynamic process and service flows, directed by business rules) for flexible business processes. Dynamic capabilities provide agility by detecting patterns and fast adaptation of business processes to events and agents (clients, businessmen, analysts and programmers, architects and process analysts).

The problems of integrating the organization architectural paradigms are useful as data warehousing and service-oriented architecture. While service-oriented architecture can be effective on a transactional, data must be integrated to support high-level management decisions. Architectural principles of the two paradigms are not completely compatible. To resolve differences between the two paradigms, practitioners have proposed several alternatives, among which service-oriented business intelligence, event-driven architecture and enterprise services bus.

The existence of service-oriented architecture allows for the management and automation of decision as decision services. The decision services are logical services of SOA that automate and manage highly targeted decisions that are part of organization's day-to-day operation (Bassett, 2007). Decision services implement operational decisions or business policies to help keep the enterprise in synch with market changes (Collard, 2009). The logic of decisions is provided by business rules defined in business rules management systems. The biggest benefits are achieved when they are stored separately in a rule repository and not integrated in applications. The decision logic code is replaced by invoking a decision service with a mechanism to receive the result from business rules management systems. This allows changing the rules without implications on the existing applications and the implementation of business rules can be carried out by business analysts, not programmers.

Developed on a standard service-oriented architecture platform, decision services provide support for making intelligent decisions for business processes managed by business process management systems. Even more, they can be connected to enterprise service bus to support loose-coupling to business processes, become part of complex event processing solution or enhance existing enterprise applications (FICO, 2009). The architecture may integrate decision services developed in other environments that support business intelligence and allow the users of business intelligence systems to perform the required changes. Figure 3 depicts a proposed architecture environment that combines the capabilities of BI, DM, BPM, SOA and other systems in order to achieve organization agility and transit towards intelligent organization. The proposed solution is focused on decisions, which leads to an organization oriented to action, reality and practice.

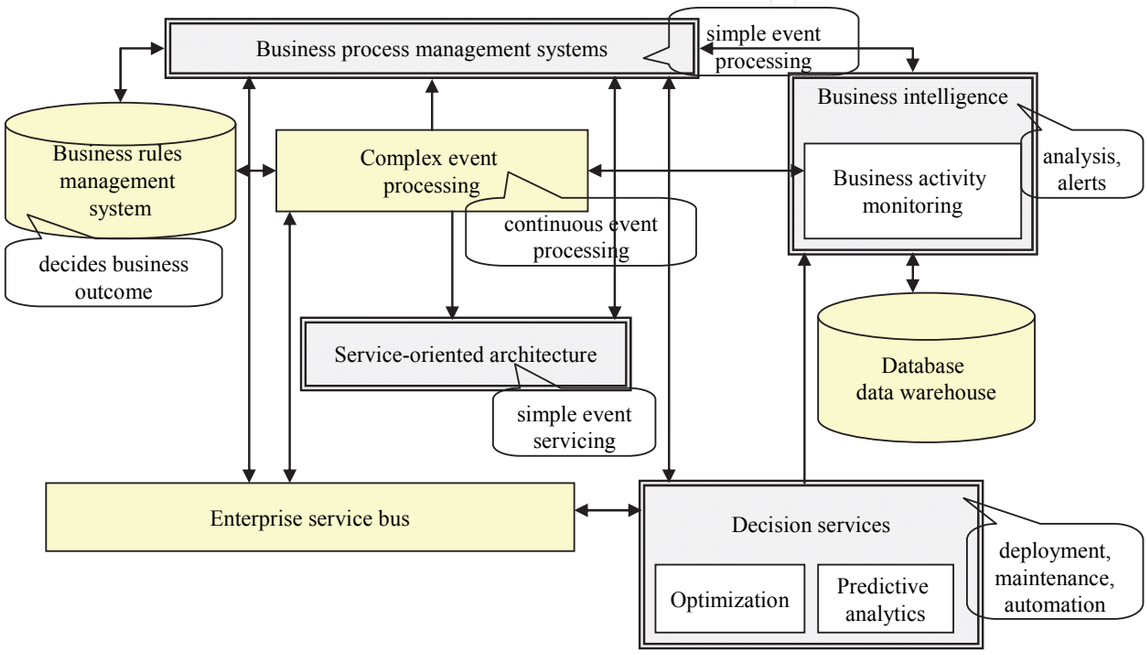

Fig. 3. Agile architecture framework based on SOA, BI, BPM and DM

Within the above architecture, service-oriented architecture facilitates the reuse of decision service through business rules, which can be exposed as web services. *Decision management* services use BRMS rule engines to process the inputs from operational systems through rule services. Additionally, BRMS rule engines process the data from separate data sources and analytic models embedded within rule service in order to return the optimal decision output (Taylor, 2005). SOA allows BPM to separate the business logic from the process logic. Also, it helps improve the availability, information consistency and access to complex and heterogeneous data (operational, transactional, analytical and unstructured information).

The proposed architectural environment ensures the link between analyzing large volumes of heterogeneous and distributed data, making consistent decisions and evaluation of current state by detection and processing of complex events. Business activity monitoring facilitates the control of event in early stages. CEP processes complex events based on business rules and provides simple business events that may be easily manipulated by BPM, BI, SOA and other instruments existing within the organization (Mircea et al., 2010). At the

same time, it provides a mechanism for the easy description of events and identification of specific patterns for complex events of the real world.

Three types of decisions to be made based on events are discernible in the context provided by CEP, namely manual, semi-automatic and automatic decisions. For semi-automatic decisions, decision management generates a series of alternatives based on results provided by the CEP engine. CEP solutions generally provide mechanisms to maintain decisions as rules that allow substantiation based on patterns of events. Combined use of BRMS and CEP leads to the finely-tuned orchestration of business information, actions and responses, enabling intelligent and responsive decision automation (IBM, 2010).

The separate placement of the rules and models repository must be observed (from which the rules will be imported to represent entries for decision services), but also the likely presence of one or more databases that, in a software system, are closely related to business rules. In the same time, business rules authoring services (responsible for business definition) are placed in a separate component. In order to facilitate the application maintenance, the knowledge base and inference engine are represented as separate entities (Andreescu & Mircea, 2009). Since rules and policies are those that will change over time, it is not practical to rewrite the code associated with each rule engine each time a new rule appears.

The combination between business rules and web services offers an adequate approach for applications integration and sharing of distributed information. 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 may be shared in a service-oriented architecture with other applications that need it. These applications communicate via XML with the business rules services (Holden, 2007).

Business process management helps optimize the business processes within the organization, but does not provide support for processes that extend beyond the organization boundaries. SOA helps solve this issue, ensuring the support required for enterprise-wide BPM (Bajwa et. al, 2008). Also, SOA allows the implementation of BPM to be focused on business processes and not on technological integration requirements (Tibco, n.d.). A service oriented approach allows reuse, governance and offers loose coupling among application modules, especially when considering enterprise-wide BPM. Used together, BPM and SOA allow using services as reusable components that support dynamic business processes (Kamoun, 2007). Business processes based on services can be designed and optimized fast and frequent, as the needs of the organization require.

As for *business intelligence*, service-oriented architecture extends their capabilities, providing support for elimination of redundancy, lack of accuracy, erroneous information (without the use of data warehouses, marts, and stores), as well as a robust architecture for data access and exchange. According to (Hansen, 2008), the best strategy is to apply service-oriented architecture principles to data integration, turning data into a service that is available as logical modules, each with a standards-based interface. Data services help transform data sources into reusable data components, facilitating the access and use and improving data visibility. The study conducted by Ventana, has identified three top benefits SOA brings to business intelligence solutions (Everett, 2006): from business perspective: to make information more broadly available, to be able to respond faster to changing business conditions and to increase the quality and consistency of data; from technological

perspective: increased responsiveness to business needs, easier integration of business intelligence with other systems and lower BI life cycle management costs. The benefits of having SOA include flexibility, responsiveness, reusability, ease of connection, cost reduction and agility (IBM, 2007).

Successful creation of new operational and business models involves the existence of an integrated and holistic approach of the information technology, business processes, organization management, structure and culture (Mircea & Andreescu, 2010). The shift to the new model cannot be done only by modernizing the information technology. Service oriented architecture provides a viable and practical approach to exploring services together with business needs (Zhao et al., 2007). The new organizational model tackles both solving current organizations issues and challenges brought by the service oriented collaborative environment.

4. From decision support to decision automation

In practice, the management decision takes two shapes: decision act and decision process. A decision becomes an act when there is a low complexity situation, repeatable and the time required to make the decision is very short – second or minutes. A decision process means a high complexity situation that requires a long time to reach a decision (hours, days or weeks). It can be defined as the sum of phases through which a management decision is prepared, adopted, applied and evaluated.

Decisions represent a critical success factor in reaching organization agility. The complexity of the decision process and frequency of changing rules and business politics imposes the need for automating decisions and decomposing human made strategic decisions into atomic business rules. The business rules must have associated quality attributes in order to be effectively exposed as services in SOA. Access to data is performed through service-oriented architecture, not by duplicating data from one operational system to another.

Decision automation means a series of tools and platforms (figure 4) used to find the model (step 1), model (step 2) and implement (step 3) the decision and define the calculation algorithm. Automated decisions are the result of translating an organization's strategic objectives into tactical business policies and requirements, which can then be implemented as decision logic for use within and across enterprise systems (IBM, 2010). Manual decisions require a human factor (business experts) and they do not allow modeling the decision. They can only be defined in a context and require human experience and judgment.

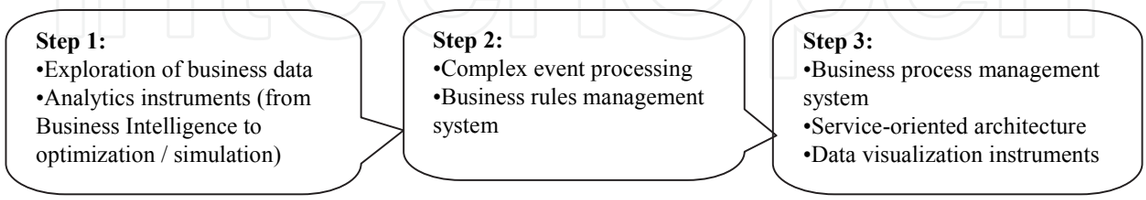

Fig. 4. A range of tools and platforms necessary in decision automation

Step1. In this step informational systems can provide the information about internal and external conditions that might affect the decision. Thus, an analysis can be performed over the organization operations or activities that take place in the business field. Also, informational systems may be used to analyze the external environment in order to identify

potential decision situations. Business analytics provide key analytical capabilities that bring additional insight and oversight to improve complex decision-making.

Foundation information can describe economic phenomena, indicating the state or behavior. They transform into potential decision type information, then into effective decision information, indicating changes that must be induced in the behavior or state of the phenomena reflected by the information. When foundation information is about notions, they can be first transformed into phenomena information and then transformed into decision type information. Thus, the information about notions passes into decision type information, indicating the changes that must be induced to the notion, which, in turn, transform into decision type information about phenomena (see figure 5).

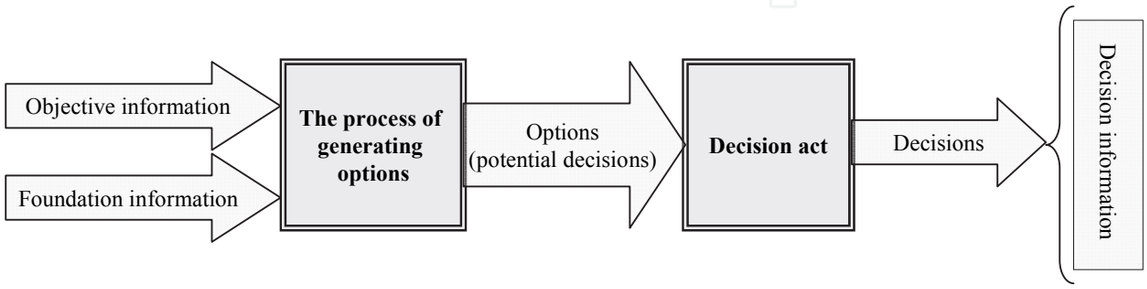

Fig. 5. How an economic decision is made (after Stoica, 2005)

An important factor in the management system is the subjectivity in consuming the information for foundation of intuitive decisions and / or giving an abnormal importance to some information in decision models. The importance of information for a decision may be measured by coefficients of participating in the foundation of the decision. Incomplete consuming of the information – giving a lower importance in making the decision – may lead to underestimating the phenomena effect and unnecessary increase of expenses to reach the goal. On the other hand, if too much importance is given, accomplishing the condition at the level set by the decision will only accomplish a part of the objective because the relation between foundation information and the decision objective is particular and its intensity is given by the dependency between the two economic phenomena or processes. Therefore, we can say that is it important to determine the participation coefficients or information in founding the decision and they must be taken into account when the decision model is built and /or intuitive decisions are made.

Another aspect of the information systems is the uncertainty of information used to substantiate a decision. The uncertainty of information is defined as a difference between the real economic process or phenomena and its representation as information. Generally, uncertainty means a lack of synchronization between the informational representation and the real economic system. Information uncertainty has a direct influence both on shaping the decision objectives and on defining the alternatives to accomplish them. Founding information uncertainty influences the uncertainty of alternatives, leading to increased expenses to reach the goal or insufficient conditions to reach it. Therefore, the uncertainty of information has a special importance in formulation and creation of conditions required to achieve the decision objective, with high influence on the efficiency of informational and management activities. Information uncertainty comes from both the limitations of

information gathering process and the way the informational system is organized and functions. From the informational system perspective, information uncertainty is determined by the quality aspects – accuracy and authenticity.

The first stage of model discovery requires tools, processes and techniques for exploration and analyses of business data. (Taylor, 2010) presents the evolution of analytics instruments from Business Intelligence, descriptive analytics, predictive analytics and optimization / simulation, according to the level of complexity. They are used for analyses and description of historical data and trends (descriptive analyses), description and predictions about the future (predictive analyses), finding the best solution for a problem under a set of constraints and a clear objective (optimization). The advanced analytics and analytic modeling capabilities can be incorporated into business intelligence architectures like analytics oriented business intelligence or they can be integrated separately into the enterprise decision management solution.

Step 2. When used together CEP and BRMS provide "always-on" mechanisms for data pattern detection and precise decision automation (IBM, n.d). Decision automation capabilities provided by rules and events may be used for complete automation of interactions, for decisional support or decisional orientation of the human factor. CEP provides a mechanism for easy description of events and identification of patterns of complex events in the real world. CEP solutions generally provide mechanisms for storing decisions as rules that allow substantiation based on event patterns.

Most BRMS products allow or even require the placement rules that will to be executed together into a set of rules (Andreescu & Mircea, 2009). The motivation resides in the need to associate rules governing a particular function of an application. For example, all rules that are related to discounts may be grouped in the set of rules "discount rules". Rules syntax checking includes the possibility to check the syntactic correctness of a rule, in real time and as the rule is introduced into the system. It is obvious that an efficient business rules management process can't be achieved without the use of suitable instruments for this purpose. There are plenty of such instruments on the market, that provide facilities for business rules acquisition and management, each covering a specific area of rules life cycle and addressing to different categories of users. BRMS (Wilson & Stineman, 2010) help automate complex, highly-variable decisions that take place in various stages of a process or separate processes within the organization.

Step 3. Business process management is used to define and orchestrate the various tasks and services that comprise the end-to-end business process (Wilson & Stineman, 2010). In most cases, the BRMS is exposed to business process management through web services that are invoked by the process to make a decision that has direct influence on how the business operates. Beside business process management and service-oriented architecture, visual interpretation of complex relations between multidimensional data with the help of data visualization instruments is a required element in implementation of the decisional model. An integrated solution will provide support for fact-based and data-driven decision making. The decision process will produce information. Without this information and without communicating it through the informational system the decision will have no effects. In all decision models the role of information in the decision making process is essential.

Decision automation largely depends on their typology; decisions may be classified based on: the way they are made (formalized and intuitive decisions), the purpose (process triggers and behavior adjustment decisions), type of decision maker (individual or group decisions), certainty of achieving the goal (certain and uncertain decisions), time frame and implications on the organization (strategic, tactical and operational decisions), frequency (periodic, random and unique decisions). Since decision automation became a feasible solution, organizations must choose what decisions to automate / semi-automate and what decisions should be left to the stakeholders.

Considering the large volume of decisions, high level of repetition and consistency, operational decisions are best suited for automation. Operational decisions are characterized by a large number of rules that change frequently and are hard to manage manually or through traditional approaches, complexity of rules, the need for business experts to understand them, the need for predictive analyses that should be integrated in the decision process, well understood factors, a relatively structured domain. In big organizations, operational decision automation generally becomes more of a survival condition than a need. The correctness and speed of making and implementing these decisions is the foundation for the existence and success of the organization.

Tactical decisions are a candidate for automation if they are complex enough and with a moderate economic impact. Generally, tactical and strategic decisions are made by decision makers and information systems provide the support for founding them. Figure 6 presents simple decisions (low complexity, low value) that are easy to automate, expert decisions (high complexity, high value) that are made with the help of decision support technologies, and between them the manual decisions. The use of operational analytics in the first stage of the decision automating process leads to an increase of the automation area, because of this main reasons (Taylor, 2010): 1. analyses of large amounts of data, finding templates, presentation of results and calculation of the risk an automated decision might have; 2. replacement / extension of personal experience in making a decision with the analyses of historical decisions made in similar cases.

Automation may be applied for information retrieval, integration and analyses, design of decision model, decision selection and /or action implementation (Parasuraman et al., 2000). During the decision model design stage, the decision case may be programmable or non-programmable, or generally structured or unstructured.

Structured decisions (programmable) are the cases where making a decision is based on a predefined procedure. Thus, decisions are structured or programmed by decision procedures or rules developed for them. A structured decision may involve a deterministic or algorithmic decision. In this case the result of the decision can be determined with certainty if a specified sequence of activities is performed (an algorithm). Also, a structured decision may involve a probabilistic decision case, where the probabilities to achieve possible results are known with an admissible margin of error.

Unstructured decisions (non-programmable) involve decision cases where it is not possible or it is undesirable to specify in advance procedures to follow in making the decision. In reality many decision cases are unstructured because they depend on random events or involve unknown factors or relations. At best, many decisional cases are semi-structured. This is why some decision procedures may be predefined but not sufficient to lead to a definitive decision.

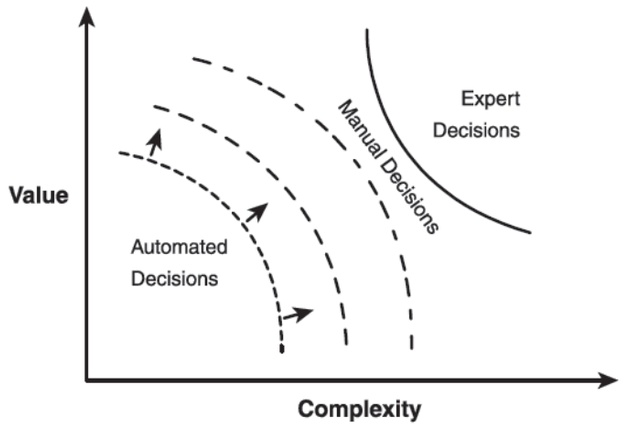

Fig. 6. Operational analytics can increase the range of decision automation (Taylor, 2010)

In order to function efficiently in a contemporary organization, the decision must fulfill some rationality requirements:

a. to have a scientific founding - management personnel must have both the knowledge, methods, techniques and abilities to make decisions as well as the understanding of market economy mechanisms;
b. to be empowered – to be made by the management body that has it as explicit work task;
c. to be integrated, harmonized in the assembly of decisions made or designed to be made – decision integration, both on vertical and horizontal of the management system guarantees the achievement of the unity of decision and action principle;
d. to fit in the optimum time frame for making and implementation – organization management must have a predictive approach;
e. to be clearly formulated – the decision must be clear, concise and state the objective and main operational parameters; in other words, the decision must indicate the objective pursued, the projected actions, allocated resources, the decision maker, the responsible for implementation, where does it apply and the time frame or deadline for implementation.

5. Conclusion

This chapter shows how business intelligence, decision management and service-oriented architecture solutions may be used together in order to create an intelligent organization that draws benefits on both short and medium / long term. The dynamics specific to modern management manifests itself at the level of the informational system, with a high level of perfection, on multiple levels. A major contribution to this is the technological development of the means to process the information. The advantages of the information technology may be capitalized only as long as managers and employees are open to change. The change must be understood as a change of human state of mind in the context of redefining the organizational culture (seen as the sum of values, beliefs, aspirations, expectations and behavior developed in the course of time in each organization, that prevail within the organization and conditions, directly and indirectly, the functionality and performance). Last but not least, we have to take into account the growing role of neo-factors of production in the current socio-economic and political context, among which

organizational information and culture are in pole position. Since business intelligence, decision management and service-oriented architecture solutions are merely some of accessible technological panaceas for collecting, transmitting, processing and using the information, the conclusion is that who owns the information and knows how to integrate it into decision making processes in a favorable market context, he shall win. He will be in position to benefit from strategic advantages and have control of the business, capitalizing on economic opportunities through the solutions proposed in this chapter (and not only) … *quod erat demonstrandum*.

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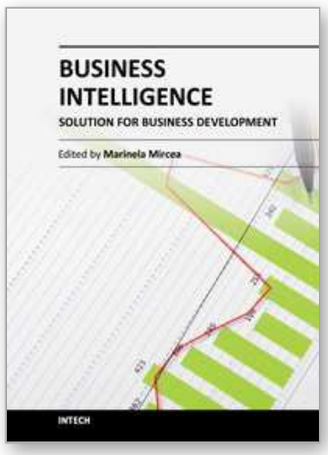

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The work addresses to specialists in informatics, with preoccupations in development of Business Intelligence systems, and also to beneficiaries of such systems, constituting an important scientific contribution. Experts in the field contribute with new ideas and concepts regarding the development of Business Intelligence applications and their adoption in organizations. This book presents both an overview of Business Intelligence and an in-depth analysis of current applications and future directions for this technology. The book covers a large area, including methods, concepts, and case studies related to: constructing an enterprise business intelligence maturity model, developing an agile architecture framework that leverages the strengths of business intelligence, decision management and service orientation, adding semantics to Business Intelligence, towards business intelligence over unified structured and unstructured data using XML, density-based clustering and anomaly detection, data mining based on neural networks.

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