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COMBINING BUSINESS INTELLIGENCE WITH CLOUD COMPUTING TO DELIVERY AGILITY IN ACTUAL ECONOMY

***Abstract.** The present economic crisis experienced by all the states of the world orients more and more the information technology industry towards efficiency. One of the instruments that can provide efficiency to an organization is Cloud Computing. At the same time, any organization is striving to become intelligent and to achieve competition advantages through the use of a Business Intelligence (BI) solution. The present paper presents aspects of the mix BI and Cloud Computing, putting the stress on the integration of a Cloud BI solution within organizations. Also, the opportunity of using a Cloud BI solution is analyzed in contrast with that of using a traditional BI solution, through the ROI indicator.*

Key-words: Business Intelligence, Cloud Computing, Return of Investment, Services Oriented Architecture, Cloud Strategy, agility.

JEL Classification: O32.

1. Business Intelligence and Cloud Computing

In the face of the current global crisis, the organizations can expect the increased uncertainty of their existence. The nature and the structure of the current dynamic world cause that nowadays, in times of uncertainty, risks and incomplete information, the crisis becomes a feature of modern business, not the state of emergency [15]. Meanwhile, the current economic crisis increasingly oriented ICT (Information and Communication Technologies) industry to effectiveness by providing new models of provision, management and IT (Information Technology) security.

In this context, the organizations are being rethought, emphasizing on the flexibility and strong sensitivity to environment and the use of strategic systems in real time. Also, there is the shift from strategic planning to strategic vision and the management instruments have new tendencies and approaches, in order to be used

effectively [28]. Therefore, organizations felt the need for proactive, integrating instruments, with strong impact compared to conventional reports, dashboards, and analyses by OLAP systems. In addition, the current management passes through the transition from certainty activities to the management under crisis conditions that requires innovation and ingenuity [28].

In the present economy, each organization tends at becoming an intelligent organization and at gaining competition advantage on the market by the use of new and innovative BI solutions. Integration of a BI solution involves a large human and financial capital, for many small and medium-sized organizations this representing an objective to attain and not a reality. Also, under conditions of recession businesses must use all the opportunities to maximize performance and minimize costs. Under these conditions, large investments in traditional BI solutions are often unpractical and unattractive, while popular solutions based on Cloud Computing, called Cloud BI or Software as a Services BI or BI services on demand are increasingly popular. Integration of a Cloud BI solution has special interest for organizations that desire to improve agility while at the same time reducing IT costs and exploiting the benefits of Cloud Computing [4].

Cloud Computing represents one of the significant trends in the development of provision, management and security of IT within an organization. At the present, Cloud Computing has no universally accepted definition. NIST (National Institute of Standards and Technology) and CSA (Cloud Security Alliance) represent a basis for defining it, as a model that provides on demand network access to a common reserve of configurable computing resources (for example, networks, servers, storing, applications and services). These may be available quickly and with minimal management effort or service provider involvement [10]. In order to better understand the concept of Cloud Computing, we present below its main features [17], [19], [10]:

- abstract computing and IT service oriented approach;
- virtual, dynamic, scalable and massive infrastructure;
- shared, configurable, flexible, dynamic resources;
- accessible via internet from any device;
- platform with minimal management or self-management;
- utilization model based on self-service;
- charging based on consumption (measured service).

A recent study [1] shows that 71% of the organizations consider Cloud Computing a realistic technological option, 70% believe that it would lead to increased business flexibility, 62% consider that it would speed up response to market conditions, and 65% consider that it would lead to increased focus on the main aspects of business. At the present there are few organizations that use Cloud Computing [23], mainly due to a lack of proper understanding of architecture, of payment models, of different business environments, and of specific elements of each organization.

Initially, cloud-based solutions have been designed for small and medium-sized organizations, as a means to ensure increased agility at low cost. Recently, an increasing number of large organizations are analyzing the possibility of rapid integration of new solutions and the use of Cloud Computing, but it still remains

mostly suited for small and medium-sized organizations [6]. As a result, the use of a Cloud Computing based solution is not suited for all organizations, especially in the field of BI [31]. Also, not all applications are good candidates for external Clouds (table 1).

Table 1. Elements corresponding to the adoption of Cloud Computing [9], [10], [13], [16], [23], [29]

Typical elements suited for external Clouds	Supplementary elements of applications suited for Software as a Service
<ul style="list-style-type: none"> - do not provide competition advantages; - do not entail a critical mission; - are not important business applications; - contain non-sensitive data; - are less affected by latency or by broadband; - uses resource patterns; - new applications; 	<ul style="list-style-type: none"> - are in reengineering stage of their lifecycle; - involve minimal personalization; - standard industrial workflow;
Supplementary elements to BI applications	
<ul style="list-style-type: none"> - less critical or standardized work (critical work suited only for large organizations); - newly created or small organizations that do not possess many data; - applications with data sources already in the cloud; - ad hoc analyses that involve a single data import from single or multiple sources; - existence of independent processes, applications and data - existence of SOA (Service Oriented Architecture) and BPM (Business Process Management). 	

Success in using Cloud Computing opportunities depends on conditions existing within the organization and on understanding of the main benefits and risks of Cloud Computing (figure 1), described in detail in [2], [3], [5], [10], [16] along recommendations on addressing risks and maximizing benefits. These are different according to the service models (IaaS – Infrastructure as a Service, PaaS - Platform as a Service, SaaS - Software as a Service) and to the development models (private cloud, community cloud, public cloud, and hybrid cloud) implemented within the organization.

Concerning the risks of Cloud Computing integration, approximately 75% of the Chief Information Officers and IT specialists consider security as the number one risk [11]. The main security risks are: loss of governance, lock-in, isolation failure, compliance risks, management interface compromise, data protection, insecure or incomplete data deletion, malicious insider [5]. Moreover, the security of Cloud BI application is vital, as these applications involve the transfer of decision support data between cloud and networks. As a result, security standards for transmitted data are very important in choosing a Cloud BI solution.

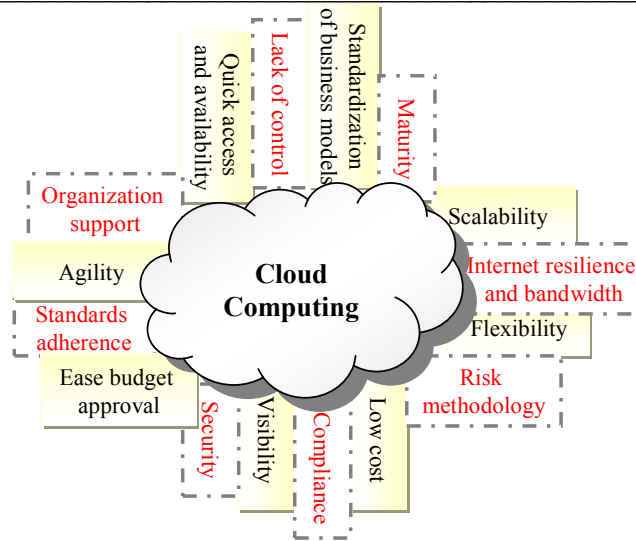


Figure 1. Benefits and risks associated to the Cloud BI solution

The problem of choosing one of the solutions of providing BI appears mainly in the business models of organizations that have an IT infrastructure. In [23] are detailed the criteria of identifying opportunities for adopting Cloud Computing by organizations. The specialists in this field consider that there will not be a complete migration from BI solutions to Cloud Computing. The migration will take place gradually and, for a long period of time, the SaaS software and the traditional software will coexist inside the organizations [20].

2. Strategy for the integration of a Cloud Business Intelligence solution

Integration of a Cloud BI solution needs a very well defined strategy that would involve Cloud Computing capabilities. As an important part of the IT strategy of the organization [29], it should adjust itself to it. Success of the implementation depends on the existence of a service oriented strategy at the level of the organization, which would provide the necessary infrastructure for the Cloud implementation. Without SOA and BPM, integration of a BI solution based on Cloud Computing serves no financial purpose, involving high costs for reengineering of the present systems [13]. Also, in order to be successful, Cloud strategy has to be in accord with the business strategy of the organization.

Based on recent research on integration of a BI solution and transition to Cloud Computing ([22], [18], [16]) we propose the following strategy of implementation of a Cloud BI solution in six stages (figure 2).

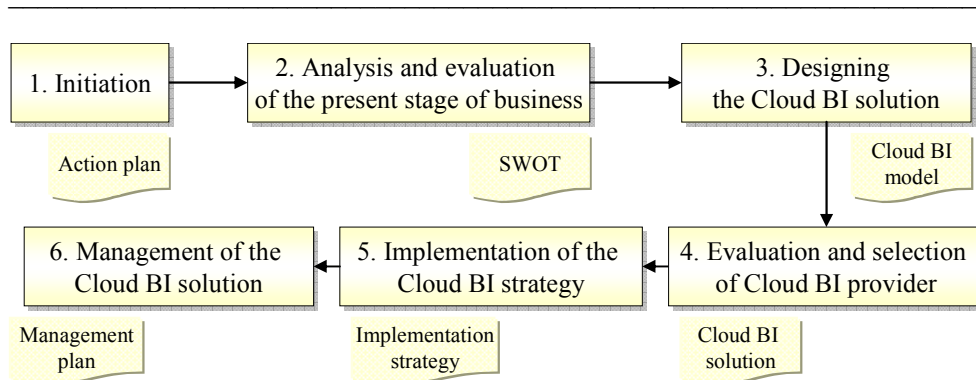


Figure 2. Stages of Cloud BI integration strategy

1. Initiation

This stage includes identifying and setting the hierarchy of business objectives, assessing the budget needed to use the Cloud BI solution, setting up the work team, the deadlines and the resources for implementation and maintenance. Also, within this stage must be identified the business' users that will perform the Cloud BI solution management and have to be involved in the following stages. The Cloud BI strategy work team must include IT personnel as well as business chiefs. They will communicate with internal and external stakeholders concerning objectives, progress, costs and benefits for each cloud project.

2. Analysis and evaluation of the present stage of business

For the success of the Cloud BI strategy it is essential to identify resources used in the daily operations and in establishing the internal operation base. Also, at the level of the organization, the present needs and possible opportunities of a Cloud BI solution have to be identified. Therefore, the present stage of business has to be analyzed and evaluated both from an internal and an external perspective of the business, putting the stress on the culture and value of business, on important business processes and business infrastructure. Evaluation of business infrastructure involves, among other things, analysis of management and security of applications, data storage, finding and classifying data [30].

At the level of the organization, Cloud Computing may be considered an extension of SOA. From this point of view it is important to identify data, services, and processes that are suitable candidates to reside in the Cloud, and the cloud services that have to be abstracted inside SOA [18] (figure 3).

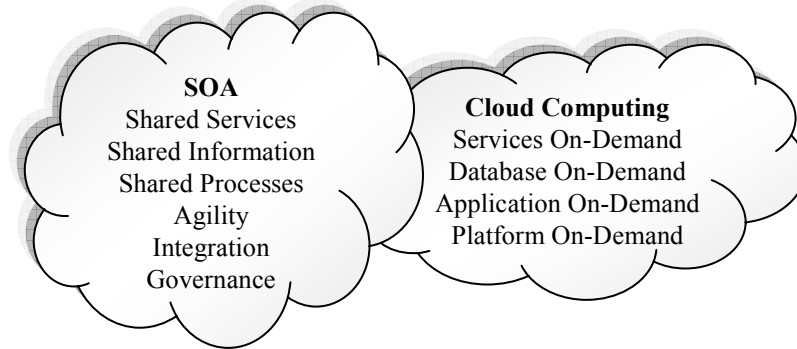


Figure 3. SOA and CC [18]

3. Designing the Cloud BI solution

The key objective of this stage is defining a method for the replication of traditional solutions using the cloud technologies (public or private) when these make sense. Also, there have to be defined the essential elements that will be the starting points in designing future architectures [32]. The result of this stage is a Cloud BI solution that fully uses the benefits provided by Cloud Computing and BI for the business operations, the infrastructure and the existing applications. Designing of the Cloud BI solution may be achieved through the following steps:

a) Mapping BI requirements and IT culture according to one of the Cloud Computing models. The key for the success of the Cloud BI strategy is obtaining the correct combination between the cloud and internal development for taking advantage of both solutions [14]. Transition to the cloud may be achieved gradually, and the software provision models will coexist for a period of time (figure 4). Taking into account the fact that most organizations are using hybrid models of Cloud Computing, maintaining key elements of their in house infrastructure, under direct control and externalizing the less sensitive components, strategic analyses have to be made in order to choose the implementation solution, concerning the decision of integration/migration. These two options may be used for the gradual transition of existing applications to Cloud Computing, for example, starting with the testing of a pilot project in the cloud and externalizing then the whole infrastructure.

b) Identification and evaluation of the different plans of verification of the benefits of the Cloud BI solution. For the evaluation of different plans, must be analyzed the types of criteria determining the opportunity of a Cloud BI solution in a specific situation [24], such as: level of personalization of data sources; priority of BI solution on the list of internal IT projects; considerations regarding security, risks, regulatory and privacy issues; development of organization and applications.

c) Identification of the main Cloud BI providers that meet the operational, technical and business requirements. Identification may be achieved based on information from search engines, consulting firms, and from other sources. Selection of candidate platforms may be made between the traditional BI providers that have adapted their offer to the cloud or/and the new providers specialized in BI products in cloud.

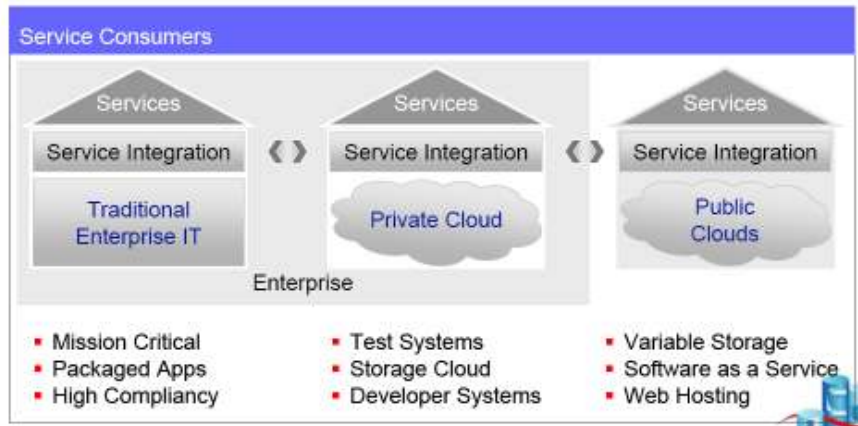


Figure 4. Coexistence of software delivery models [24]

4. Evaluation and selection of Cloud BI provider

Due to the profound changes on the technological market generated by the globalization and the new economy, the relation between the forces present in the field of BI and Cloud Computing may gain new valences and polarizations. As a result, the evaluation of solutions/providers has to be done based on the most recent sources (provider, consulting firms, the newest articles), the rest of the sources of information representing the grounds for obtaining a global image of the market of BI in Cloud Computing (figure 5). Within this stage takes place the analysis and testing of Cloud BI solutions, the selection of candidate solutions, identification of major changes and obtaining insurance from the selected Cloud BI providers.

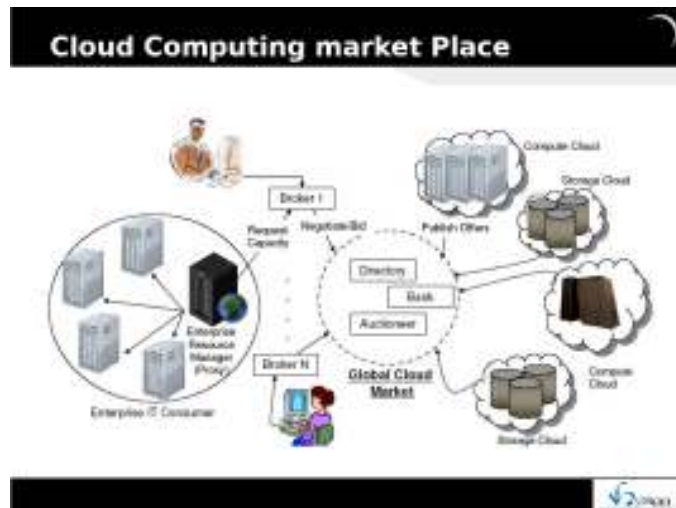


Figure 5. CC Market [21]

The model of decision for choosing the Cloud BI solution combines strategic factors and techniques with cost-benefit analyses for decisions of

migration, versus integration or keeping *in house* (figure 6). The major decisions, in this model, are: ❶ strategic analyses for grounding decisions of migration/integration/keeping based on business factors; ❷ architectural analyses based on intangible cost-benefit analyses of strategic decisions and ❸ the selected solution based on the analyses made.

The process of selecting the Cloud BI strategy is iterative and is based on the results of the technical and economical analyses. Every iteration identifies and eliminates the platforms of solutions that are unacceptable or unavailable, configurations that are too expensive or solutions with an unacceptable level of security. The number of iterations depends on the number of available candidate solutions.

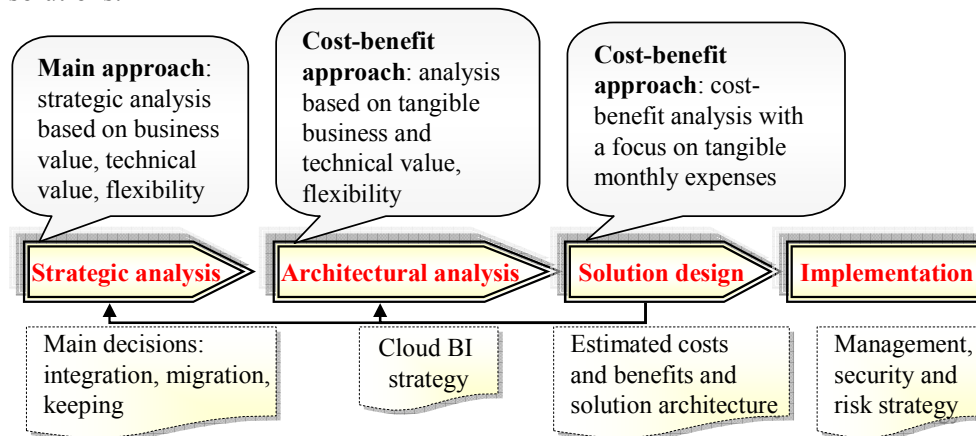


Figure 6. Decision model for choosing a Cloud BI solution

Based on the final offer of the provider, the team will measure the impact on the organization of the selected solution, assessing costs and benefits in order to determine the opportunity of integration and the key elements under negotiation. Finally, based on the offer and the model of contract, the contractual elements are negotiated: price, service conditions, payment, obligations of the parties, etc., and the contract is closed. In selecting a BI solution, organizations have to take into account the newest trends on the BI and Cloud Computing market, the present and future needs and the opportunity of integration. In order to be successful, the selection of a Cloud BI solution has to be achieved objectively by a team of specialists based on good criteria that have been analyzed and weighted according to the present and future needs of the organization.

5. Implementation of the Cloud BI strategy.

Implementation of the solution may be achieved in iterative stages, through continuous transmission of data, services and processes toward the cloud, with possible returns from the cloud to operations hosted internally (figure 7). This is achieved through continuous evaluations of the benefits of cloud technologies. Also, implementation involves setting a flexible program of risk management (to cope with IT risks that are increasing continually) [10], testing the solution's performance and the management of implementation.

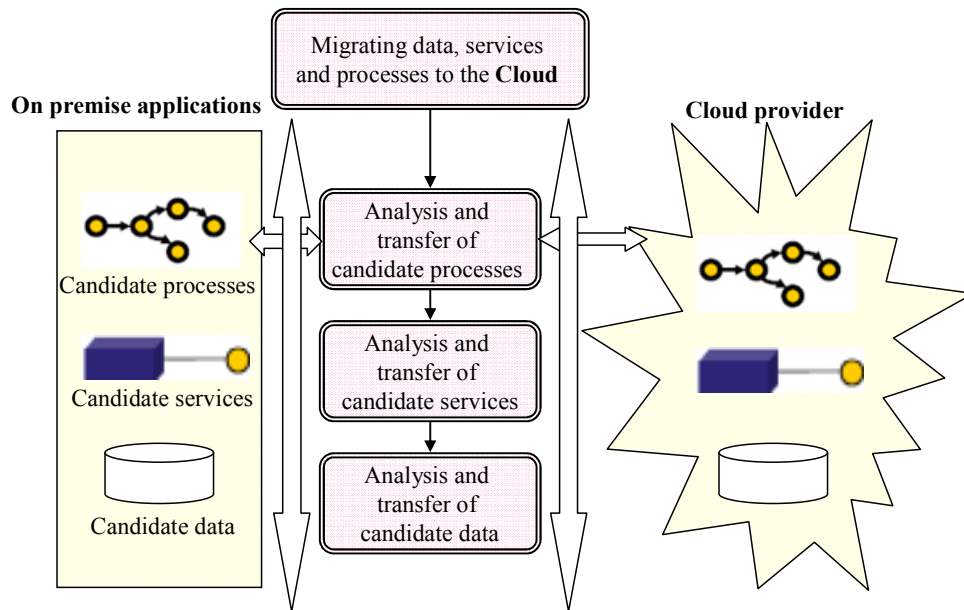


Figure 7. Implementation of Cloud BI strategy

Migration of data, services and processes to the Cloud platform must be achieved based on well defined models/strategies. Every migration model involves specific objectives, according to the policies of the organization, the control and security of information. Data migration must be achieved by keeping the optimal balance between data accuracy, speed of migration, time of non-operation and minimal costs (figure 8).

Utilization of a Cloud BI solution involves changes in the manipulation of processes, such as data processing, development, receipt of information, means of storage, archiving and saving data, etc. Migration of critical applications and infrastructure to the Cloud and maintaining the business activity involves important human resources for the management of sensitive data and of applications during migration [30]. At the end of the solution's implementation takes place the training of users in operating the new systems.

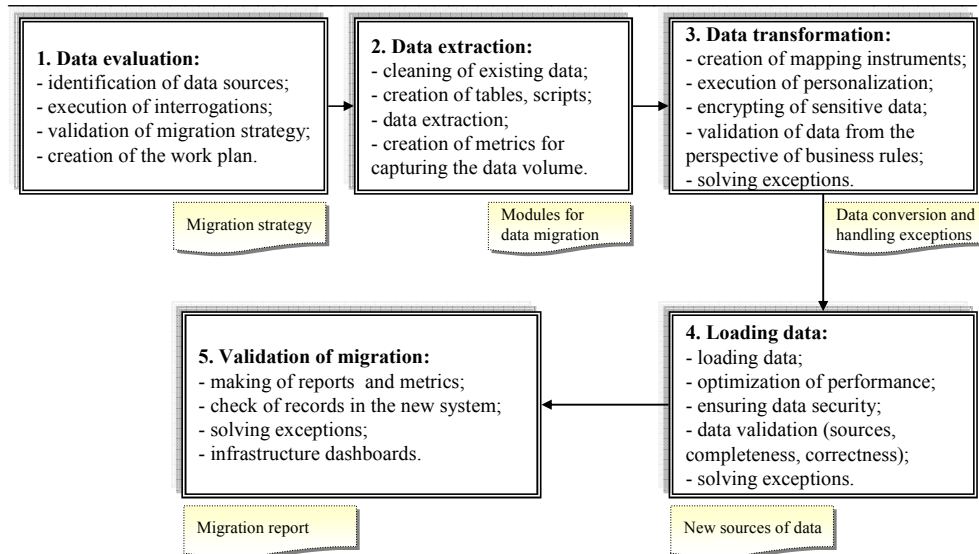


Figure 8. Migration of data to the Cloud

6. Management of the Cloud BI solution

At the level of the organization must be present a management model that should include policies on security, the management of applications and infrastructure, risk management and continuous evaluation of the Cloud BI solution. An efficient management is essential for any quality management program. It supports proactive ensuring of quality by measuring and improving processes, procedures and services.

Besides the typical components under the audit of a BI solution, detailed in [7], in monitoring the Cloud BI solution must be taken into account the specific elements of Cloud Computing environment. Among the most important are: monitoring URLs, monitoring system resources, monitoring log files, event management, multi-client capabilities, evaluation of contracts with providers.

3. Analysis of the opportunity of using a Cloud BI solution

Evaluation of a Cloud BI solution represents a difficult process of analyzing risks and associated costs and benefits by a team of managerial staff and ITC specialists. Initial evaluation is followed by a series of analyses taking place after each year of use in order to check the initial estimations and to possible correct the way of operation.

At the present there are different types of cost-benefit analyses, providing an image on the costs/benefits involved by Cloud Computing (e.g.: [25], [23] where models are limited mainly to the measurement of costs and savings) and Business Intelligence (detailed in [8]). The approach proposed in this article provides a perspective on the calculation of ROI (Return of Investment) indicator associated to a BI solution in the Cloud environment, stressing the difference between the traditional means and Cloud.

The problem of choosing between one of the two solutions or the use of a hybrid solution appears generally within organizations with a certain level of IT. The selected Cloud BI solution and the transition strategy (e.g. integration or partial/total migration) will influence the calculation of the ROI indicator within the organization.

Below, we present the ROI components, differentiated into two models of providing the BI software.

$$ROI_{BI} = \frac{TB - TC}{ITC}, \quad (1)$$

where TB represents the total benefits following implementation of the BI solution, TC represents the total costs of BI solution, and ITC – initial total costs of the solution.

$$ROI_{CloudBI} = \frac{IPB + DCB - CloudTC}{CloudTC}, \quad (2)$$

where IPB represents the benefit obtained as a result of increased profit, DCB represents the benefit obtain as a result of decreasing costs by the use of a Cloud solution, $CloudTC$ represents the total costs generated by the Cloud environment (after [23]).

The benefit reached by decreasing costs through the use of a Cloud BI solution may be calculated according to the formula:

$$DCB = \Delta IHC + \Delta ISC + \Delta IIC, \quad (3)$$

where IHC represents the initial hardware costs, ISC represents initial software costs, and IIC initial implementation costs for a traditional BI solution, detailed in [8]. Within these costs an important role is that of decreasing number of hardware equipments, of costs generated by the spaces used and of the license costs.

The benefit obtained as a result of increasing profit following the use of intangible advantages of a Cloud BI solution may be calculated according to the formula:

$$IPB = IAB + ISB + MB + ISB + CB + RB + GITB + UTB, \quad (4)$$

where IAB represents the benefit obtained by increased agility, ISB – the benefit obtained as a result of increased scalability, MB – the benefit from reducing the time of response to the market demands, ISB – the benefit obtained as a result of increased clients' satisfaction, CB – the benefit obtained as a result of focusing business on the main competences, RB – the benefit obtained as a result of disaster recovery, $GITB$ – the benefit obtained as a result of using Green IT, UTB – the benefit obtained as a result of better use of time, detailed in [23].

In selecting a BI solution must be also taken into account the risk of implementation associated to that solution. Through the implementation of the solution the benefit obtained must surpass the costs of capital and compensate the risk associated to the project. Many of the specific risks of the Cloud environment (generally middle and low level risks, which do not entail important losses for

business) can be transferred to the Cloud providers. Among the types of risks that are specific to Cloud Computing we mention the high level risks (table 2), among the 35 risks identified and evaluated in [5].

Table 2. High level risks specific to Cloud Computing

Risk category	Risks
Policy and organizational risks	R.1 Lock-in
	R.2 Loss of governance
	R.3 Compliance challenges
Technical	R.9 Isolation failure
	R.10 Cloud provider malicious insider - abuse of high privilege roles
Legal	R.21 Subpoena and e-discovery
	R.22 Risk from changes of jurisdiction
	R.23 data protection risks
	R.26 Network management (ie, network congestion / mis-connection / non-optimal use)

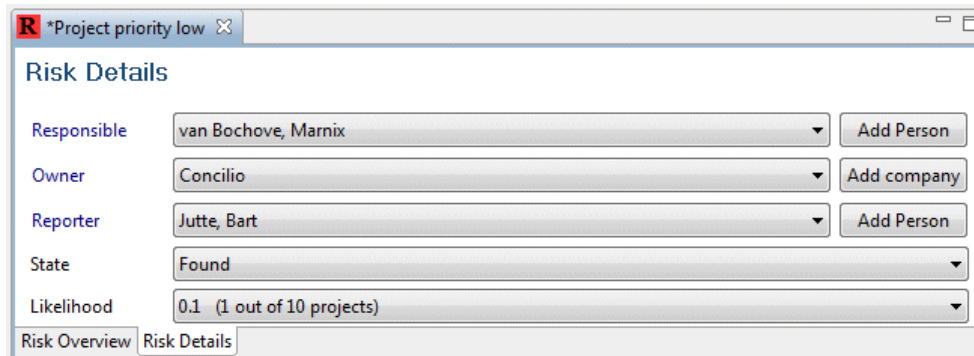
Successful implementation of Cloud BI solution depends on adequate risk management. The result will be that you minimize the impact of project threats and seize the opportunities that occur [12]. The 10 golden rules to apply risk management successfully in your project, described in [12] are: ● make risk management part of your project; ● identify risks early in your project; ● communicate about risks; ● consider both threats and opportunities; ● clarify ownership issues; ● prioritize risks; ● analyze risks; ● plan and implement risk responses; ● register project risks; ● track risks and associated tasks.

Generally, the risk management activity is perceived to be an efficient one in case in Romanian organizations. A significant part of respondents [26] indicated that risk management is a key function of their company; it's integrated in the culture of the company and is a source for competitive advantages.

Organizations use different tools/products for risk management and analysis of different scenarios. Any instrument should provide at least the following benefits:

- Risk Manager: define risk strategies, prioritize risks and take action (figure 9);
- Risk Analyzer: analyze the causes and effects of project risks;
- Risk Register: keep track of all risks and activities in a central database;
- Risk Response planner: generate and execute and monitor responses to optimize risks;

- Risk knowledgebase base: use a set of standard risks that frequently occur in projects.



The screenshot shows a web application window titled '*Project priority low'. The main content area is titled 'Risk Details'. It contains several form fields with dropdown menus and buttons:

- Responsible:** van Bochove, Marnix (dropdown) with an 'Add Person' button.
- Owner:** Concilio (dropdown) with an 'Add company' button.
- Reporter:** Jutte, Bart (dropdown) with an 'Add Person' button.
- State:** Found (dropdown).
- Likelihood:** 0.1 (1 out of 10 projects) (dropdown).

At the bottom of the form, there are two tabs: 'Risk Overview' and 'Risk Details', with 'Risk Details' being the active tab.

Figure 9. Information to manage project risks

(Source: <http://www.projectfuture.net/uk/projectfuture-software/screenshots>)

Among the tools that can be used in risk management, remember ProjectFuture, which offers all the benefits mentioned above or The @ Risk for Project informatics product that allows the achievement of a plan rather flexible to the modifications which could occur during the business development and applies to sensitivity analysis and scenarios analysis. The @ Risk adds over 37 probability distribution functions to Microsoft Project program. In order to perform risk analysis, Monte Carlo simulation technique is used [27]. The products does not eliminate the risks associated to a certain complex project, but have the necessary tools for the best decisions in order to schedule the business activities, when delays, unexpected costs or other deviations could occur.

Conclusions

The present article represents a supplementary argument in favor of the idea that the information and communication technology makes its presence felt in all the areas of social and economic life. Built on the structure of the global network – internet, the network economy has in our days a spectacular development, representing the element of maximal emergence of information society.

In this context, the economic organization – as main actor in the global economic game – has to adapt as it goes in order to develop but especially in order to survive. Therefore, a Cloud BI solution may be a feasible answer to the challenges of the economic crisis. By such a solution, the economic organization – small, middle-sized or large – may use market opportunities that under normal conditions (other than adopting BI or Cloud BI) would not be accessible.

Moreover, considering the perspective of Cloud Computing characteristics, adopting a Cloud BI solution at the level of business may represent the premises of organizations passing to a superior form of information society – the virtual organization. Thus, by sharing resources and increasing market integration speed, by increasing the speed of business processes and integrating traditional BI

solutions, the proposed Cloud BI strategy may be an answer for adapting the organizations to the present economic and social conditions.

Last but not least, the evaluation of the economic efficiency of the proposed solution by the relation cost – performance based on the ROI indicator represents another argument in favor of the feasibility of a Cloud BI strategy.

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