Conference Paper

Decision Support Models When Choosing Cloud-base IT-services for Enterprise Deployment

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Abstract

Developing an IT-strategy of cloud deployment is a complex issue since even the stage of its formation necessitates revealing what applications will be the best possible to meet the requirements of a company business-strategy, evaluate reliability and safety of cloud providers and analyze staff satisfaction. The present paper suggests a system approach to evaluate the effectiveness and risks resulted from the integration of cloud-based services in machine-building enterprise. This approach makes it possible to estimate a set of enterprise IT applications and choose the applications to be migrated to the cloud with regard to specific business requirements, technological strategy and willingness to risk. A system of criteria as well as integrated model to assess cloud deployment effectiveness is offered.

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1. Introduction

In the last few years, Information Technology (IT) has embarked on a new paradigm – cloud computing. Although cloud computing is only a different way to deliver computer resources, rather than a new technology, it has sparked a revolution in the way organizations provide information and service. Cloud computing is a comprehensive solution that delivers IT as a service [1, 2].

The process of managerial decision-making concentrated on deployment of cloud-based technologies is to be organized in line with assessment of their economic efficiency and utilization risks. The specifics of strategic decision-making consist in incompleteness and inaccuracy of reference information, typical for conditions that kind of decisions is made in. As the consequence, an expert has to describe circumstances relying both on quantity and quality characteristics. An expert's knowledge is a determining factor when selecting a cloud service [3, 4].

This problem can be resolved by a multi-criteria approach and fuzzy sets theory. They is applied for decision-making. It enables us to carry out simulation of a smooth change in object properties as well as revealing unknown functional dependencies expressed as attribute-based relations [5-7].

The paper focuses on design and implementation of a system approach, which involves assessment of economic efficiency and risks analysis caused by integration of cloud-based IT-services, allowing managers of enterprises to come to a correct decision concerning the integration.

2. System approach to assessment of efficiency and risks caused by transition to cloud-based IT-services

The problem of insufficient comprehensive methodological base and tools to support decision making, which rely on the processes of efficiency assessment and risks in conditions of uncertain decision making environment is currently the urgent one in the sphere of cloud-based technologies integration. This issue is relevant for businesses of all branches and levels [8]. To solve a problem of this kind a system approach is to be applied, as well as method of system analysis. Fig. 1 demonstrates the outline of system approach to assess efficiency and risks caused by integration of cloud-based IT-services.

The first stage **«Identifications of expenditures and benefits»** involves calculation of expenditures and benefits from transition to cloud-based services.

The second stage "**Assessment of expenditures and economic benefits**" concerns the assessment of the model available. At this level, the model is identified. It will be used to provide services according to functional and legal requirements of business (identified on the first stage).

The third stage **«Efficiency calculation»**is supposed to determinea base period: a planned period to use cloud-based services (a 5-year period is recommended). Then we calculate criteria and indices of efficiency and risks [8, 9] according to suggested models (Fig. 1).

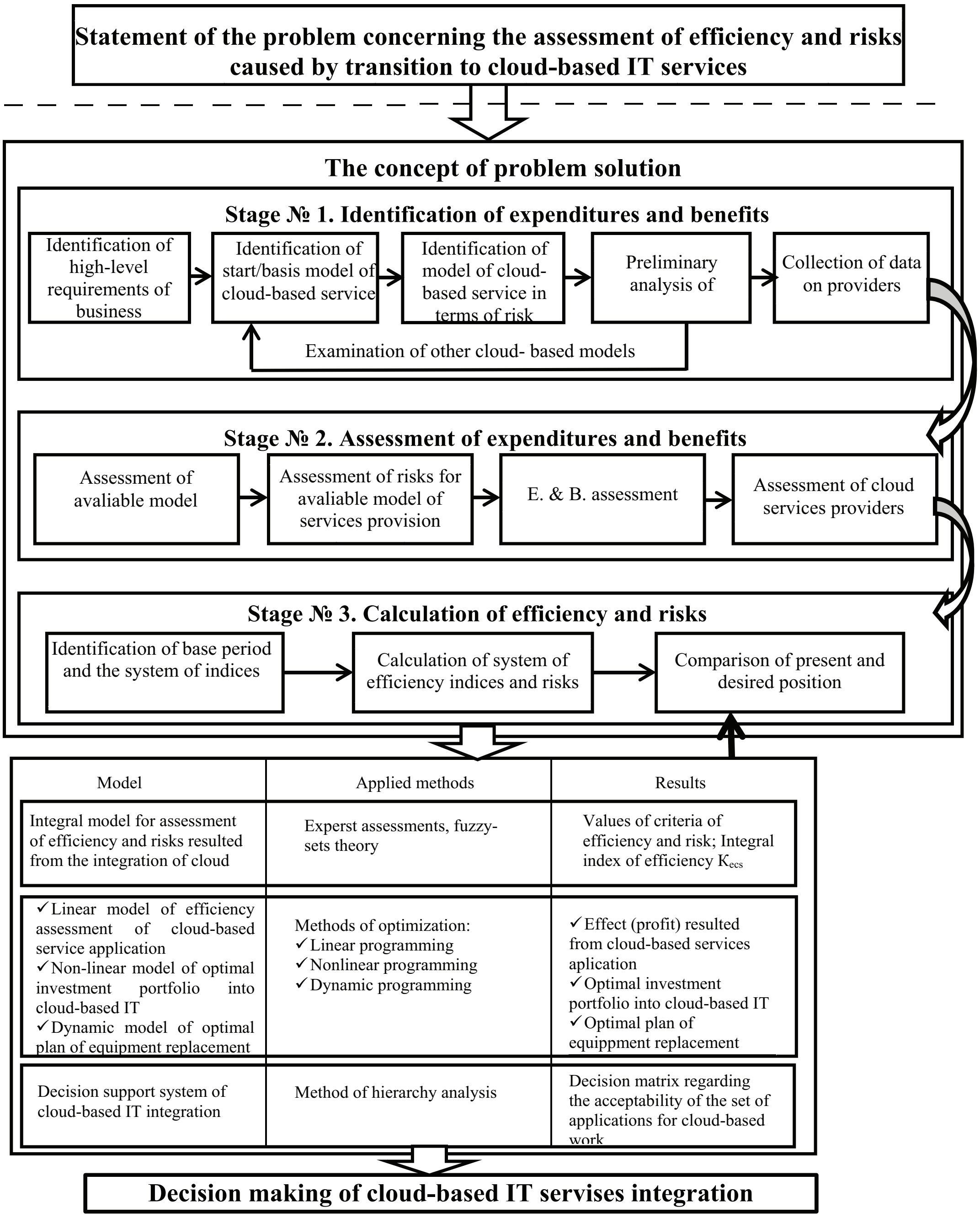

Figure 1: System approach to the assessment of efficiency and risks caused by transition to cloud-based IT services.

3. Procedure of calculating criteria and integral index "Effectiveness of a cloud-based service"

"Effectiveness of a cloud-based service" calculated according to suggested model [9]. The stage concerning criterion Kecs calculation and risks experts and financial department are to be engaged in work, as well as corporative standards are to be met.

We compare further the present position and that one to be achieved:

1. Numerical indices for direct and well-estimated benefits are assessed.
2. Expenditures resulted from transition to the cloud are calculated.
3. Expenditures and economic benefits of the present and desired position are compared.
4. Net expenditures and profits for each year are calculated.

This approach can be reduced to giving a more precise definition of the problem and structuring it in a number of tasks soluble by economic and mathematical methods, revealing criteria for their decision, and making purposes more detailed.

The integral index is calculated by hybrid additive and multiplicative formula (1):

$$_{ecs} = Is \cdot (a_1 \cdot Eb + a_2 \cdot Fb + a_3 \cdot Tp + a_4 \cdot Dr + a_5 \cdot Pf), \quad (1)$$

where K_{ecs} – integral index "Effectiveness of a cloud-based service";

Eb – value of criterion "Efficiency for business";

Fb – value of criterion "Financial benefit";

Tp – value of criterion "Technological priority";

Is – value of criterion "Work reliability and information safety";

Dr – value of criterion "Degree of risk";

Pf – value of criterion "Psychological factor".

a_1, a_2, a_3, a_4, a_5– weight coefficients.

The above criteria have ranks (weight coefficients) to ensure compliancy. Calculating the coefficients an expert has to take into account the range of criteria scale and average statistical numerical scores of a criterion. Research revealed the distinction between weights determined by an expert and those ones resulted from his/her activities. The weights of the most essential criteria are usually underestimated while those of less important criteria are overrated. Therefore, to avoid subjectivity pairwise comparison method is used when allocating weights [9]. Weight coefficients are values of vector $r_i$calculated according to formula$r_i = 1 / \sum_{i=1}^{n} k_i$, where k is a sum total of pairwise comparison matrix column *i*, hence vector r_i have the following structure. $r_i = (a_1; a_2; a_3; ..; a_n)$. The number of weight coefficients for the presented criteria is different. This is due to the number of indicators in the criteria. The number of indicators corresponds to the number of weight coefficients. Detailed formulas for calculating performance criteria are presented in [9].

4. The algorithm to calculate criteria of efficiency

1. Comparison with required indices and standards regarding the information of cloud-based IT-service provider. The main principle of comparison is that of compatibility of results in terms of accepted scale of expert estimates (Table 1).

2. The expert assesses to which extent cloud computing meets the requirements of safety on the basis of score assessment and according to the scale. To score a decimal scale from 0 to 1 is used.

3. The criterion is calculated according to Formula 1.

Iteration of indexes is eliminated in the method, enabling objective estimation of effectiveness of cloud-based IT-service application.

Table 1: Preference scale of indexes (criteria).

Value of index	Verbal expression of an index (criterion) of cloud-based service effectiveness
1	Effectiveness index is very high (exceeds the standard one twice and more)
1.00...0.75	Effectiveness index is quite high (exceeds the standard one by 75-100 %)
0.75...0.5	Effectiveness index seems to be high (exceeds the standard one by 50-75 %)
0.5	Average effectiveness index (at level of the standard one)
0.5...0.25	Effectiveness index seems to be low (0-25 % lag behind the standard one)
0.25...0	Effectiveness index is quite low (25-50 % lag behind the standard one)
0	Effectiveness index is very low (100% lag behind the standard one)

5. Model of decision support on the transition to cloud-based services

Some of the questions businesses need to ask themselves before undertaking cloud initiatives are:

- What factors should I consider for cloud enablement of my enterprise applications? How do I judge different competing priorities?
- How do I identify the applications and services that are best suited for moving to a cloud environment based on business priority and technical fitment?

- How do I prioritize enterprise applications and services for a ”phase-smart” cloud enablement? How can I avoid that ”gut feeling” and bring objectivity into the evaluation?
- What are the different risks involved?

A decision support model for switching to cloud IT services based on the Analytic Hierarchy Process (AHP) is proposed (fig 2) [10].

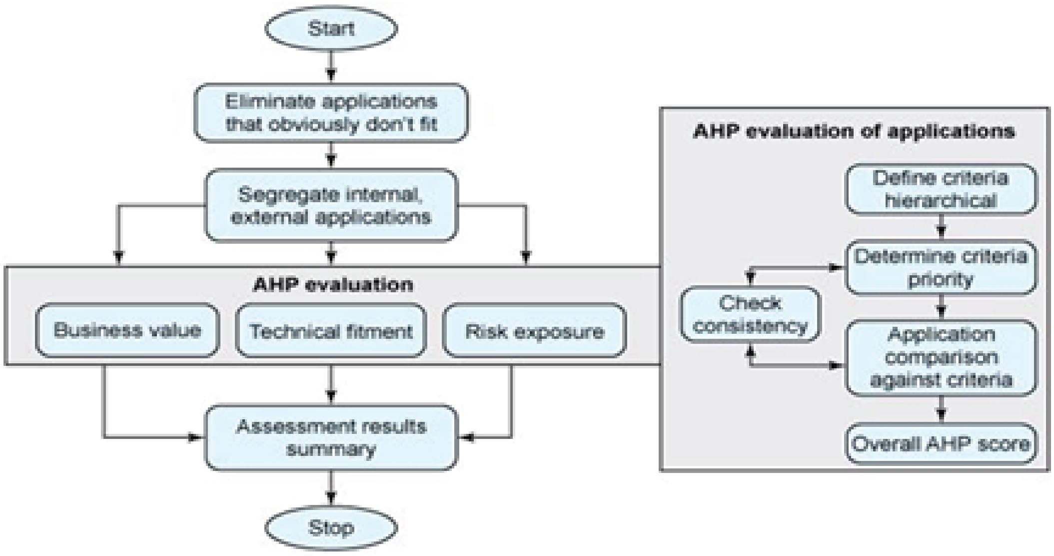

Figure 2: Flow chart of application portfolio assessment for cloud.

The approach is a multi-dimensional statistical evaluation; enterprise applications are evaluated in three dimensions:

- Business value: How much business value would the organization accrue by moving the applications to cloud?
- Technical fitment: How feasible is it to move the applications to cloud?
- Risk exposure: How much risk is involved in moving the applications to cloud?

Each of these dimensions has decisive effect on a go/no-go decision regarding cloud enablement of applications. For example, an application may be evaluated to have high scores in the business value and technical fitment dimensions, but it may not be a good candidate for cloud enablement if the risk exposure is higher than the level of risk a particular enterprise is willing to assume.

There are several components, or steps, involved in using AHP to evaluate the suitability of an application for the cloud. These include:

- Defining criteria hierarchy.

- Determining criteria priority.
- Comparing your application against the criteria.
- Calculate overall AHP score.

Each of the multiple dimensions (business value, technical fitment, risk exposure) has a number of criteria; these in turn can further have multiple levels of granular sub-criteria (Fig 3).

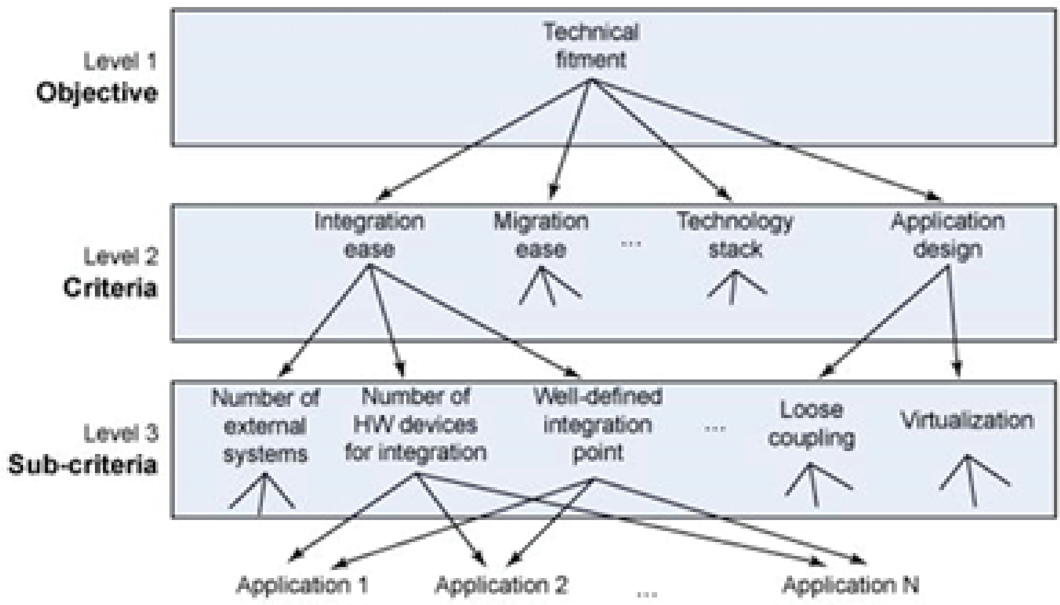

Figure 3: Schematic representation of AHP for evaluating cloud technical fitment.

Criteria pertaining to different dimensions are structured in hierarchy of levels in accordance with the AHP framework. Figure 2 shows the hierarchy structure for a technical fitment evaluation. Criteria and sub-criteria can be either quantitative or qualitative. For example "No of External System" is a quantitative value while "Well Defined Integration Point" is a qualitative one. A cluster of criteria and its sub-criteria is called a **criteria group**. For example, in Figure 3, criteria "Application Design" and its two sub-criteria, "Loose Coupling" and "Virtualization," belong to same group making it a criteria group of three group members.

Relative priorities are assigned for different criteria using the 1-9 scale of AHP (Table 2).

Table 2: AHP's 1-9 scale of criteria priority; scale for pairwise comparison.

Intensity	Definition	Explanation
1	Equal importance	Two elements contribute equally to objective
3	Moderate importance	Slightly favor one element over another
5	Strong importance	Strongly favor one element over another
7	Very important	Very strongly favor one element over another
9	Extreme importance	Extremely favor one element over another
2, 4, 6, 8	Intermediate values	

The overall AHP score of an application for a dimension is derived by the sum of the product of its relative priority in each criteria and the relative priority of respective criteria

$$S_x = \sum_{i=1}^{M} \sum_{j=1}^{N_j} (P_i) * (p_{ij}) * (s_{ijx}).$$

In this formula:

S_x is the AHP score for the xth application;

M is the number of criteria group;

N_i is the number of the members in the ith criteria group;

P_i is the priority value of the ith criteria group;

p_{ij} is the priority value of the jth criteria belonging to the ith criteria group;

s_{ijx} is the score of the xth application comparison against the jth criteria in the ith criteria group.

6. Results and Discussion

Once the AHP evaluation is done for all three dimensions, application scores can be collated to arrive at a decision matrix, a sample of which is shown in Table 5. The group at the top is best suited for cloud deployment; each successive group is less suited for cloud distribution.

The matrix will provide a holistic view of the impact of cloud enablement of different applications in an enterprise against different dimension and will aid in making an informed decision.

Table 3: Sample suitability decision matrix.

Application Score: Business Value	Application Score: Technical Fitment	Application Score: Risk Exposure	Suitability
High	High	Low	Favorable on all dimensions. Applications in this group are most suitable for cloud enablement; their score is favorable on all dimensions.
High	Low	Low	Favorable in two dimensions. Applications in this group are also suitable for cloud enablement; they score favorably in in at least two dimensions.
Low	High	Low	Favorable in two dimensions.
High	High	Low	Favorable in two dimensions.
Low	Low	Low	Favorable in one dimension. Applications in this group are favorably in only one dimension.
High	Low	High	Favorable in one dimension.
Low	High	High	Favorable in one dimension.
Low	Low	High	Favorable in no dimensions. Applications in this group are best left ”as-is”; their score is not favorable on any dimensions.

The status of ”high”, ”low” or ”medium” is assigned based on the number of applications evaluated. The status of ”high” have an application whose score is more than 25% of the total score (the number of evaluated applications), which is equal to one; from 20% to 25% - ”low”; less than 15% - ”low”.

Given the concerns and risk involved in cloud computing initiatives, each enterprise has to assess its application portfolio based on its business imperatives, technology strategy, and risk appetite before embarking on a flight into the clouds. With this assessment that involves multiple competing criteria of varied nature, impact, and priority, we've demonstrated how a multi-dimensional statistical approach using the Analytic Hierarchy Process (AHP) can be used to help decide which, if any, of your enterprise applications belong in the cloud.

7. Conclusion

The paper suggests a system approach to assess the efficiency and risks caused by cloud-based IT-services integration. We have developed an outline of a system approach, which includes 3 stages of assessment: identification of expenditures and economic benefits, estimation of expenditures and benefits, calculation of efficiency and risks.

The system of criteria as well as integrated model to assess effectiveness of cloud services deployment are presented in the paper. The integrated model of effectiveness assessment based on the system of criteria enables making a decision what applications will be the best possible to meet the requirements of a company business-strategy, evaluate reliability and safety of cloud providers and analyze staff satisfaction even at the phase of strategy formation.

The paper suggests a four stages model of decision support on migration of enterprise applications in the cloud. The model is different from other available models as it allows evaluating the possibility of moving IT-applications to the cloud as per three aspects: business value, technical feasibility and degree if risk. The applied method of hierarchy allows using quantitative and qualitative criteria in decision making, group them into levels and sublevels, formalize experience and knowledge of experts. To summarize estimations, obtained in three aspects, a matrix of decisions on suitability of applications for migrations in the cloud is created. The matrix allows obtaining specific recommendations concerning decision making for moving a specific application in the cloud.

The suggested model of evaluation allows selecting application for moving into the cloud, which is an urgent task in conditions of an enterprise limited IT-budget.

References

[1] Maricela-Georgiana Avram (Olaru) Advantages and challenges of adopting cloud computing from an enterprise perspective // *Procedia Technology* 12 (2014). – p. 529-534.

[2] Latifa Ben Arfa Rabaia, Mouna Jouinia, Anis Ben Aissab, Ali Mili A cybersecurity model in cloud computing environments // *Journal of King Saud University* - Computer and Information Sciences. – 2013 – Vol. 25, Issue 1. – p. 63-75.

[3] Yaojun Han, Xuemei Luo Hierarchical scheduling mechanisms for multilingual information resources in cloud computing // *AASRI Procedia 5 (2013).* – p. 268-273.

[4] Kumar Garg S, Buyya R 2012 SLA-based admission control for a Software-as-a-Service provider in Cloud computing environments, *Journal of Computer and System Sciences*, 78 (5), pp 1280-1299.

[5] Amir Mohamed Elamir, Norleyza Jailani, Marini Abu Dakar 2013 Framework and architecture for programming education environment as cloud computing service,

Procedia Technology 11 pp 1299-1308.

[6] Paul P K, Ghose M K 2012 Cloud Computing: possibilities, challenges and opportunities with special reference to its emerging need in the academic and working area of Information Science, *International conference on modelling optimization and computing.* Volume 38, pp 2222-2227.

[7] Marston S Li, Bandyopadhyay S, Zhang J, Ghalsasi A. 2011 Cloud computing – The business perspective, *Decision Support Systems*. Volume 51, Issue 1, April 2011, pp 176-189.

[8] Razumnikov, S., Kurmanbay, A. Models of evaluating efficiency and risks on integration of cloud-base IT-services of the machine-building enterprise: A system approach // IOP Conference Series: Materials Science and Engineering 124(1), 2016.

[9] Razumnikov, S., Prankevich, D. Integrated Model to Assess Cloud Deployment Effectiveness When Developing an IT-strategy // IOP Conference Series: Materials Science and Engineering 127(1), 2016.

[10] Razumnikov S.V., Kremnyova M.S. Decision support system of transition IT-applications in the cloud enviroment // *2015 International Siberian Conference on Control and Communications (SIBCON) : proceedings*, Omsk, May 21-23, 2015.