Selecting an IT Outsourcing Strategy under Uncertainty

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***Abstract*— A model enabling a substantiated decision to use the IT outsourcing under uncertainty on the basis of analysis of the project stakeholder's competence and project impact on the project stakeholder's information security is developed.**

Keywords*— *IT outsourcing; innovation project; fuzzy logic; information security

I. INTRODUCTION

The development of Russian economy is inextricably linked to high technologies and innovations. The software development/maintenance processes typically account for a rather high share of science-intensive product creation projects exemplified in [1–3]. Such projects are also characterized by a high pace of introduction of new information technologies and sophistication of those in use. The use of IT outsourcing is often expedient under such conditions to achieve economic, technological and strategic advantages. This is confirmed by Russian information technology market statistics as well: the IT outsourcing sector was 16% up, and reached 88.4 bn rubles in 2016 [4]. All this actualizes the purpose of this paper, which is to develop a method for selecting an IT outsourcing strategy within the framework of an innovation project.

II. RELATED WORKS

The issues related to deciding on expedience of using the IT outsourcing are considered in papers [5–7]. Despite an undoubted theoretical and practical significance of said studies, it should be noted that they mainly consider the issue from the viewpoint of expedience of outsourcing individual functions, not developing a strategy within the framework of an innovation project. We are also of the opinion that these studies pay insufficient attention to the information security issue. In addition, it should be noted that said papers fail to take into account the specific feature of innovation projects, which is the necessity of making decisions under uncertainty. Given the above, it was concluded that the problem is insufficiently theoretically elaborated in economics, which confirms the relevance of this paper.

III. STRATEGY SELECTION MODEL

It is expedient to reduce the selection of an IT outsourcing strategy within the framework of an innovation project to the multi-criteria selection from many non-dominated alternatives. Matrix analysis possessing the advantage of simple result interpretation for the decision-maker (DM) is one of the methods used to perform this class of tasks. We propose the decision-making matrix shown in Fig. 1. Alternative strategies are described in Table I.

TABLE I. IT OUTSOURCING STRATEGIES

Strategy	**Description**
Internal service	The project significantly affects the information security, therefore the development by third party contractors is undesirable. The organization possesses a high level of IT competence for implementing the project using its own resources
Selective outsourcing	The organization possesses a high level of IT competence for implementing the project using its own resources. The project insignificantly affects the organization's information security, therefore third party contractors can be involved to increase economic efficiency.
Full outsourcing	The organization cannot implement the project using its own resources because of low IT competence. The low project impact on information security makes the involvement of third party contractors expedient
Competence development	Project failure risks are high, as works cannot be carried out using own resources and third party contractors cannot be involved because of high impact on information security. It is expedient to delay the project until a sufficient IT competence is accumulated or to review the project implementation terms

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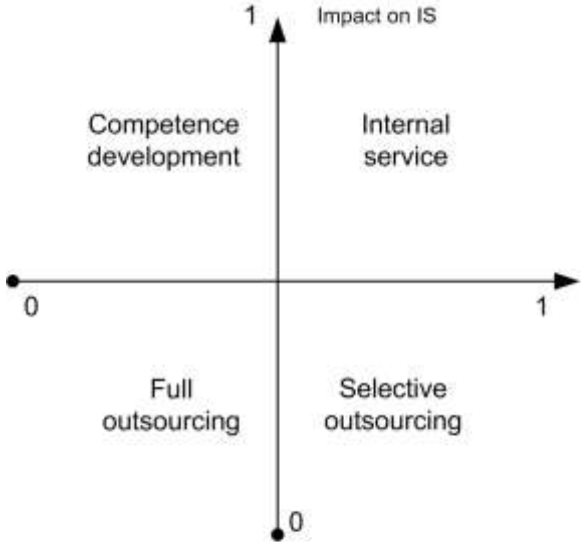

Fig. 1. IT outsourcing strategy selection matrix

We suggest that two criteria should be used in selecting the IT outsourcing strategy: the project stakeholder's IT competence and project impact on information security.

A. Criteria for assessing the project impact on the stakeholder's information security

The national information security management system standard considers the information security (IS) at the top level as a 'security triad' consisting of availability, confidentiality and integrity [8]. We suggest that the information resources affected by the innovation project should be identified and assessed using the criteria taking into consideration all 'security triad' aspects from Table II. Target function Y_1 describes information security dependence on the set of criteria in that case: $Y_1 = f(x_1, x_2, ..., x_n)$.

We suggest that linguistic variable $\beta_i = \langle \beta, T, X, G, M \rangle$ be defined for each criterion $X_i (\mathrm{i} = \overline{1...n})$. Let us review the linguistic variable definition procedure for one of the criteria – "losses caused by loss of goodwill as a result of data confidentiality compromise" (the procedure is identical for the remaining criteria). We suggest that the three-element set {'minor losses', 'acceptable losses', 'critical losses'}, one of the most widely used ones, should be used as linguistic variable term set T [9].

A precise assessment on the basis of these criteria is complicated by that innovation projects are planned and implemented in an uncertain external or internal setting. Probabilistic approaches are often used to assess the uncertainty, but the search for statistical data for innovation projects and the assessment of their relevance are complicated by their relatively project-specific nature. We suggest that fuzzy logic should be used to remove uncertainty in this connection.

TABLE II. IS CRITICALITY ASSESSMENT CRITERIA

Availability	Confidentiality	Integrity
Direct and indirect losses caused by business process breach as a result of information resources unavailability	Cost of commercial data with read access through information resources	Direct and indirect losses caused by business process breach as a result of data integrity compromise
	Direct and indirect losses caused by data use by competitors	Cost of the data accessible through information resources
Losses caused by SLA contract breach as a result of information resources unavailability	Direct and indirect losses caused by loss of goodwill as a result of data confidentiality compromise	
	Losses caused by breach of the legal or contractual terms of third party confidentiality	Cost of the data integrity recovery procedure

Universal set X is set $\left[X_{\min}, X_{\max}\right]$ with the minimum and maximum possible losses as its boundaries. The procedure for defining fuzzy subsets A_{ij} on universal set X implies building membership functions for term set components to define their inclusion in subsets A_{ij} on the basis of expert assessment, which is a time-consuming task, and has only to be performed at the system setup stage, not on each decision making [10]. Fuzzy subsets A_{ij} are represented as fuzzy triangular numbers $D_{ij} = (d_1, d_2, d_3)$ in this paper. As a result, membership functions will take the form shown in Fig. 2 for the linguistic variable "losses caused by loss of goodwill as a result of data confidentiality compromise". Membership functions are similarly built for all other criteria.

The result of project expert assessment on the basis of each criterion is a fuzzy triangular number such as "insignificant losses caused by SLA contract breach" or "critical cost of commercial data". We suggest that project impact on information security should be assessed as a normalized additive assessment convolution by the following criteria: $Y_1 = \sum_{i=1}^{n} X_i / C_{crit}$, where $C_{crit} = \sum_{i=1}^{n} C_i$ is critical loss from project information security risks.

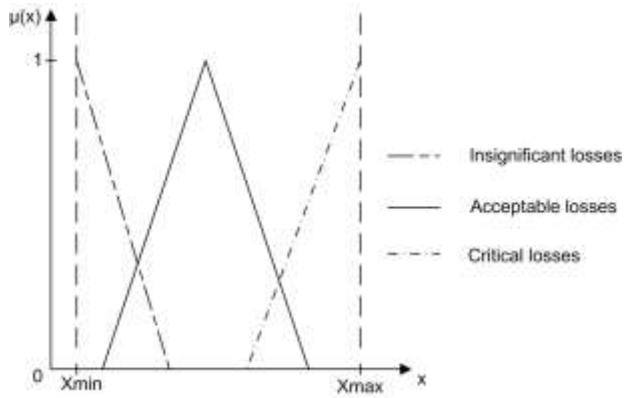

Fig. 2. Linguistic variable membership functions

As all fuzzy subsets are represented by triangular numbers, the algebraic sum was calculated as follows during convolution: $d_1(d_{11},d_{12},d_{13})+d_2(d_{21},d_{22},d_{23})=\mathrm{d}(\mathrm{d}_{11}+d_{21},\mathrm{d}_{12}+d_{22},\mathrm{d}_{13}+d_{23})$.

The convolution results in a fuzzy set characterizing the project impact on information security. As all convolution criteria were represented by triangular number, the fuzzy set obtained is a triangular number too, and an example of its membership function is shown in Fig. 3. Defuzzification, i.e. conversion to a crisp number, is required to map the fuzzy set obtained onto 'crisp' axis Y_1 of the IT outsourcing strategy selection matrix. The following formula should be used for triangular number $D=(\mathrm{d}_1,\mathrm{d}_2,\mathrm{d}_3)$: $\overline{D}=(\mathrm{d}_1+2\mathrm{d}_2+\mathrm{d}_3)/4$ [11]. The number obtained as a result of defuzzification is marked on axis of the matrix from Fig. 1. A point has to be defined on axis Y_2 to finally select the strategy.

B. *Project stakeholder's IT competence assessment criteria*

CMM (Capability Maturity Model) for Software is the most widely used standard, including organization's information service competence assessment [12].

Although the standard covers a fundamentally broad range of software developer capacity completeness assessment-related issues, it provides no specific IT competence assessment criteria. Nevertheless, this standard underlies the criteria proposed by the authors and listed in Table III. Target function Y_2 describes IT competence dependence on the set of criteria in that case: $Y_2 = f(x_1, x_2, ..., x_n)$.

This Table shows that the proposed criteria are qualitative in nature and have no physical measurement scale. The point rating method is often used to assess objects using such criteria. Despite the popularity of this method, it is characterized by low stability, rough assessments, and poor conformity to the relevant features of the individual assessment process [13].

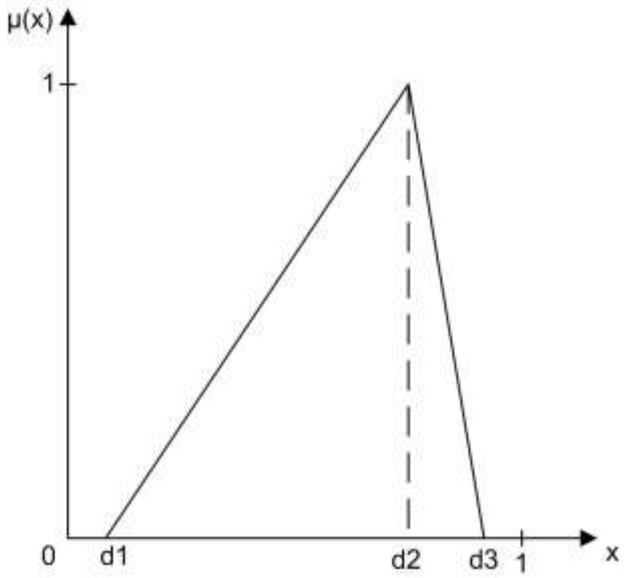

Fig. 3. Example of membership function for the fuzzy set "Project impact on information security"

TABLE III. IT COMPETENCE ASSESSMENT CRITERIA

Engineers' qualification
Existence of a group of engineers
Incidence of the practice of result review and audit
Speed of response to incidents and their processing speed
Relevance of the technological and tool stack used
Use of automated quality assurance tools (static analyzers, automated testing)
Process conformity to the information security policy and standards
Project similarity to previously implemented projects

Linguistic variables are used in this paper to assess IT competence in this connection, as they adequately simulate the experts' thinking and are successfully used to formalize expertise and experience [14].

Each criterion $X_i(\mathrm{i}=\overline{1...n})$ is represented in the form of linguistic variable $\beta_i=\langle\beta,T,X,G,M\rangle$ with universal set $[0,1]$ and 3-element term subset in that case, e.g. for the crterion "Engineers' qualification: low engineers' qualification, medium engineers' qualification, high engineers' qualification" (the term sets are similar for other criteria). Fuzzy subsets A_{ij} of corresponding linguistic variables are represented as triangular numbers $D_{ij}=\left(d_1,d_2,d_3\right)$.

A fuzzy number is the result of IT competence assessment on the basis of each criterion. Then additive convolution of the criteria is the final IT competence assessment. Criterion importance varies with project characteristics, therefore introduction of weighting factors seems to be expedient.

The standard weight calculation method is that proposed in [15]. This method consists in pairwise comparison of criteria i and j resulting in number α_{ij} reflecting the fact that the first indicator is more important than the second one. These factors are used to approximately find weighting factors α_i meeting the following condition: $\sum_{i=1}^{n}\alpha_i=1$. As a result, the project stakeholder's IT competence assessment is calculated as weighted additive convolution of criteria: $Y_2=\sum_{i=1}^{n}\alpha_i X_i$. The defuzzification of the triangular number $D=(\mathrm{d}_1,\mathrm{d}_2,\mathrm{d}_3)$ obtained gives crisp number Y_2 that should be marked on the appropriate axis of the decision-making matrix shown in Fig. 1.

C. *Strategy selection decision-making*

We suggest that an IT outsourcing strategy containing the point of intersection of perpendiculars drawn through points Y_1 and Y_2 in its cell should be selected. One or both points may lie at the intersection of axes (i.e. Y_1 and/or Y_2 equals 0.5, see an example of such situation in Fig. 4).

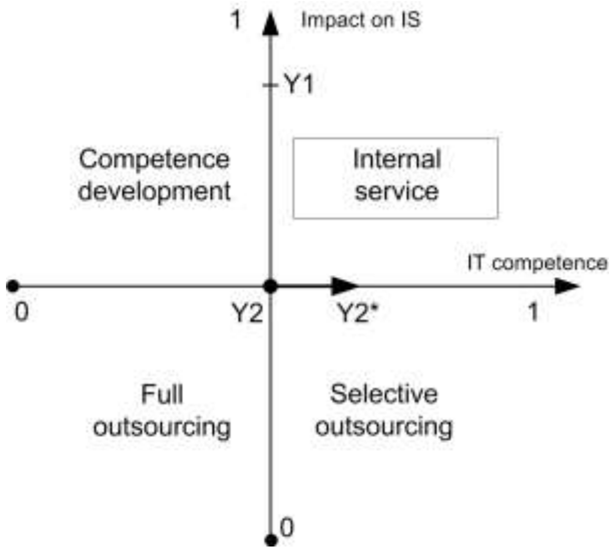

Fig. 4. Example of a situation where the IT competence assessment lies at the intersection of axes

An unequivocal decision matrix-based strategy selection is impossible. We suggest that the general project development scenario should be relied upon in such situations. If such scenario is optimistic, then the strategy corresponding to a criterion value that is more 'positive' than the point of axis intersection should be selected. Otherwise, the strategy corresponding to a 'negative' criterion value should be selected (an example for optimistic development scenarios is shown in Fig. 4).

IV. Conclusion

The proposed approach enables selecting an IT outsourcing strategy on the basis of project impact on the project stakeholder's information security and competence. The approach enables making decisions using fuzzy logic in uncertain external or internal settings where innovation projects are often implemented. The proposed approach can be used to improve the economic information system life cycle management tools in practice.

References

[1] Sarkisov P.D., Stoyanova O.V., Dli M.I. Principles of project management in the field of nanoindustry. Theoretical Foundations of Chemical Engineering. 2013. Vol. 47. No. 1. Pp. 31-35.

[2] Dli M., Ofitserov A., Stoianova O., Fedulov A. Complex Model for Project Dynamics Prediction. International Journal of Applied Engineering Research. 2016. No. 11(22). Pp. 11046-11049.

[3] Dli M., Zaenchkovski A., Tukaev D., Kakatunova T. Optimization Algorithms of the Industrial Clusters' Innovative Development Programs. International Journal of Applied Engineering Research. 2017. No. 12(12). Pp. 3455-3460.

[4] Rynok IT-uslug i IT-autsorsinga Rossii. ("Russian market of IT services and IT oursourcing"). Available at: http://www.tadviser.ru/index.php/Статья:ИТ-услуги_(рынок_России) (accessed 19 April 2018).

[5] Ignat'ev A.V. The algorithm, of ICT-outsourcing decision making in SME. *Sovremennoe issledovanie sotsial'nykh problem* [Russian Journal of Education and Psychology]. 2012. No. 7(15). Pp. 2-19. (In Russian).

[6] Mansurova N.A., Rumyantseva Yu.O. Support for management decision-making in the transition to IT outsourcing. *Ekonomicheskie issledovaniaya* [Economics Research]. 2015. No. 4. Pp. 13-26. (In Russian).

[7] Buyanov D.A. Model of decision-making on the use of IT outsorcing. *Vestnik YuUrGU. Seriya: Ekonomika i menedzhmen* [Bulleting of the South Ural State University. Series: Economics and management]. 2015. No. 1. Pp. 96-103. (In Russian).

[8] State Standard ISO/IEC 27001-2005. Information technology – Security tecniques – Information security management systems – Requirements. Moscow. Standartinform Publ. 2008. 26 p. (In Russian).

[9] Shtovba D. Razdel Fuzzy Logic Toolbox (Shtovba D. Fuzzy Logic Toolbox section). Available at: http://matlab.exponenta.ru/fuzzylogic/book3/default.php (accessed 19 April 2018).

[10] Kruglov V.V., Dli M.I., Golunov R.Yu. *Nechetkaya logika i iskusstvennye neyronnye seti* [Fuzzy logic and artificial neural nets]. Moscow. Fizmatlit Publ. 2001. 224 p.

[11] Chen S.M. Evaluating the rate of aggregative risk in software development using fuzzy set theory. Cybernetics & Systems. 1999. Vol. 30. No. 1. Pp. 57-75.

[12] Paulk M. Capability maturity model for software. Encyclopedia of Software Engineering, 2002. DOI: 10.1002/0471028959.sof589

[13] Akimov V.A., Lapin V.L., Popov V.M. *Nadezhnost' tekhnicheskikh sistem i tekhnogennyy risk* [Reliability of technical systems and technogenic risk]. Moscow, Delovoy ekspress Publ., 2002. 367 p.

[14] Zadeh L.A. The concept of a linguistic variable and its application to approximate reasoning. Information sciences, 1975, vol. 8, no. 3, pp. 199-249.

[15] Saaty T.L. How to make a decision: the analytic hierarchy process. Interfaces, 1994, vol. 24, no. 6. pp. 19-43.