2nd International conference on Quality of Life
June 2017
Center for Quality, Faculty of Engineering, University of Kragujevac

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THE EVALUATE OF A NEW DEVELOPING PROJECTS UNDER UNCERTAIN MARKET

Abstract: *This paper investigates the vulnerability of projects which are implemented in the reverse supply chain focusing on the issue of vulnerability assessment in the planning stages of the project before its realization. The expert and management team assesses the variables of project's vulnerability by using common measurement scale. In daily business practice, project activities may be exposed to different risk sources which may be studied from different perspectives. The model of project's vulnerability assessment is verified on real life data by means of an illustrative example.*
Key Words: *project management, vulnerability, assessment*

1. INTRODUCTION

Project management covers wide area of industrial engineering and management deals with many open issues (Vidal and Marle, 2012). Amongst all, significant issues in project management are oriented to risk management (Marcelino-Sádaba et al., 2014), and project system vulnerability (Deng et al., 2014). The increasing application of project management practice brings the need for the research and decision making analysis of the overpowering existing and new challenges. So it is visible in different areas of life and business, and market shows constant demand for project managers (Shimizu et al., 2014).

A major problem may be bad definition of the role of project management activities and insufficient support from top management (Hermano and Martín-Cruz, 2016). When the project comes into the final phase, any delay will increase the total costs of the project, so awareness of project managers has to be focused on project management methods (Kostalova et al., 2015) with a goal to enable faster and more efficient implementation with taking resources into account (time, money, human resources, material resources, etc.).

Vulnerability, as the term in literature, is used in different aspects such as information systems (Patel et al., 2008), supply chains (Wagner and Neshat, 2015), monitoring systems (Pingue, 2011), but at the same time, lesser number of papers treat business organization issues. Emerging insights into organizational vulnerability can significantly add to research agenda of organizational risk management (Liu et al., 2013), as vulnerability may be presented as a multidimensional concept that consists of exposure, sensitivity and adaptive capacity (Turner II, 2003) to the manifested scenarios of potential risks. In the terms of strategy, vulnerability management may be associated with a goal to minimize the negative consequences that arise from changes in the organization's or reverse supply chain activities, so the business performance may be recovered (Chowdhury and Quaddus, 2015). Exposure to negative consequences can induce new possible incidents, so it is important to handle vulnerabilities and respond to them effectively and quickly. In order to provide long term sustainability (Afgan et al., 2009), organizations need to be flexible, striving to develop their staff and to provide better competences so that they could develop increased static adaptive capacity. In this way, organization could respond to changes and possible perturbations in a way of resetting their own performance and recover from stress. Generally, the vulnerability can be presented as a multidimensional concept that consists of exposure, sensitivity and adaptive capacity (Turner II et al., 2003). When vulnerability concept comes to the area of project management, it may be noticed that there are very few papers that deals with named issue (Vidal and Marle, 2012).

The motivation for this paper is derived from the desire of the author to depict the disadvantages and vulnerabilities of project management that are currently occurring in different reverse supply chains in Serbia. In order to assess vulnerability of project management, the problem is treated through the following steps: definition of project phases, assessment of project phases' sensitivity to potential risks, enterprise's static ability to recover its business performances (adaptive capacity), and assessment of project phases' exposure to risks (susceptibility) that may occur during project delivery.

The aim of this paper is to present a model for assessment of the vulnerability of different projects originating from one type of possible risks in the planning stages before its realization. The vulnerability of the project could be analyzed through the whole phases of the project taking into account analysis of risk factors. The proposed model has been verified by the illustrative example in one reverse supply chain in Serbia.

The paper is organized as follows: In the first section, the basic considerations are given about projects' vulnerability. The evaluation framework is presented in Section 2. The proposed model is presented in Section 3. Section 4 is denoted as an illustrative example for the model testing and verification. Section 5 sets the conclusion, the paper contribution and future directions in the research.

2. EVALUATION OF FRAMEWORK

The evaluation framework for vulnerability assessment of each project phase is proposed in figure 1.

Step 1. This paper focuses on projects which are realized in reverse supply chain with partner relations within a supply chain.

Step 2. Project may be defined as a set of phases which are successively implemented (PMBOK Guide, 2013). The total number of phases of the project is denoted as F and f is the index of project phases f, f=1,..,F. The number of phases is determined in compliance with project management methodology (PMBOK Guide, 2013): Project conception and initiation (f=1), Project definition and planning (f=2), Project launch or execution (f=3) Project performance and control (f=4), Project close (f=5).

Step 3. This paper treats the group of technical and technological risks since it has significant impact on the type of treated reverse supply chain. The total number of risks is denoted as R and r is the index of risks r, r=1,..,R. The following list notes the major technical considerations that can affect business risks (BS 6079-3:2002): inadequate design (r=1), professional negligence (r=2), human error/incompetence (r=3), structural failure (r=4), operation lifetime lower than expected (r=5), residual value of assets lower than expected (r=6), dismantling/decommissioning costs (r=7), performance failure (r=8), residual maintenance problems (r=9).

Step 4. In the treated problem, the sensitivity of each project phase, the quality or condition of being sensitive to accidents, occurs from potential risks. The value of sensitivity of each project phase f, f=1,..,F, for each treated risk r, r=1,..,R is based on the evaluation of the expert team. Decision makers articulate their assessment on the common measurement scale.

Step 5. Exposure of each project phase is defined as the state of having no protection from something harmful – accidents occur from potential risks. Exposure of each project phase f, f=1,..,F to risk r, r=1,.., R if it is manifested through the possible accident is assessed by each member of management team on the level of the enterprise where the analyzed project should be realized. The aggregation of their opinions is given by using fuzzy averaging method. The value of exposure of each project phase f, f=1,…,F for each treated risk r, r=1,…,R is denoted by precise numbers which belong to common measurement scale.

Step 6. Static adaptive capacity of each project phase f, f=1,…,F if risk r, r=1,…,R, is manifested, is seen as a level of existing procedure plans or strategies that are supposed to be implemented if accident occurs. Its value is based on assessment of the management team on the level of the reverse supply chain p, p=1,…,P.

Step 7. Vulnerability of each project phase f, f=1,…,F for each risk r, r=1,..,R, is calculated as a product of normalized values of its sensitivity, s_{fr}, exposure, e_{fr} and static adaptive capacity, a_{fr}.

Step 8. At the first place in the rank, the phase f, f=1,..,F which is associated with the highest value of vulnerability is placed. It may be assumed that vulnerability of the analyzed project is equal to the vulnerability of the first ranked project phase.

3. THE PROPOSED MODEL

The proposed model can be shown through further steps.

Step 1. Rating of each project's phase sensitivity, S_{fr}, exposure, E_{fr} and static adaptive capacity, A_{fr} on the level of each risk is performed by decision makers which make decision by consensus. They assessment are mapped into common measurement scale. The values of treated scale.

Step 2. Transformation of all assessed values into interval [0-1] by using vector normalization procedure (Pomerol and Barba-Romeo, 2000).

a) for benefit type criterion

$$s_{fr} = \frac{S_{fr}}{\sqrt{\sum_{f=1}^{F} \left(S_{fr}\right)^2}}, \quad e_{fr} = \frac{E_{fr}}{\sqrt{\sum_{f=1}^{F} \left(E_{fr}\right)^2}},$$

$$f = 1,..,F; r = 1,..,R$$

b) for cost type criterion

$$a_{fr} = \frac{1/A_{fr}}{\sqrt{\sum_{f=1}^{F} \left(1/A_{fr}\right)^2}}, \quad f = 1,..,F; r = 1,..,R$$

Step 3. Calculation the vulnerability of each phase of the project with respects to all identified risk is calculated:

$$V_f = \frac{1}{R}\sum_{r=1}^{R} s_{fr} \cdot e_{fr} \cdot a_{fr}$$

Step 4. Ranking of project phases in the treated reverse supply chain is performed respecting vulnerability. At the first place in the rang a phase is placed which is denoted as f^*, f=1,..,F with the greatest value associated $V_f, f = 1,..,F$.

4. ILLUSTRATIVE EXAMPLE

The proposed model is tested on real life data from one reverse supply chain from Serbia. In the treated reverse supply chain, one research project was analysed.

The rating of sensitivity, exposure and static adaptive capacity for each phase of the project at the risk level r, r=1,..,R are presented in Table 1 to Table 3 (Step 1 to Step 3 of the proposed Algorithm). These data presents input data for the proposed model.

Table 1. *The rating of project phases' sensitivity*

Project phases/ Technical-operational risk factors	r=1	r=2	r=3	r=4	r=5	r=6	r=7	r=8	r=9
f=1	4	2	1	2	3	1	1	4	4
f=2	5	4	3	6	6	1	5	5	6
f=3	6	5	5	5	5	6	6	7	7
f=4	1	4	6	4	2	5	4	1	4
f=5	1	1	2	1	1	3	2	1	1

Table 2. *The rating of project phases' exposure*

Project phases/ Technical-operational risk factors	r=1	r=2	r=3	r=4	r=5	r=6	r=7	r=8	r=9
f=1	3	1	3	3	5	2	5	1	1
f=2	6	4	6	9	8	6	6	6	7
f=3	9	6	5	4	7	7	7	8	8
f=4	3	5	4	3	5	6	2	4	5
f=5	1	4	2	5	2	1	1	3	2

Table 3. Fuzzy rating of project phases' adaptive capacity

Project phases/ Technical-operational risk factors	r=1	r=2	r=3	r=4	r=5	r=6	r=7	r=8	r=9
f=1	2	2	2	1	2	1	3	2	2
f=2	3	2	1	3	3	2	2	3	2
f=3	2	1	1	2	1	1	1	1	1
f=4	3	3	2	2	2	3	2	2	3
f=5	1	5	5	5	5	5	3	3	3

The normalized values (Step 2 of the proposed Algorithm) of sensitivity and exposure for reach project phase at the risk level r, r=1,..,R are calculated and presented in Table 4, Table 5, and Table 6.

Table 4. The values of sensitivity of project phases on the level of each risk

Project phases/ Technical-operational risk factors	r=1	r=2	r=3	r=4	r=5	r=6	r=7	r=8	r=9
f=1	0.450	0.254	o.115	0.221	0.346	0.118	0.111	0.417	0.368
f=2	0.563	0.508	0.346	0.663	0.693	0.118	0.552	0.521	0.552
f=3	0.675	0.635	0.577	0.552	0.577	0.707	0.663	0.729	0.644
f=4	0.113	0.508	0.693	0.442	0.231	0.589	0.442	0.104	0.429
f=5	0.113	0.127	0.231	0.111	0.116	0.354	0.221	0.104	0.092

Table 5. The aggregated value of exposure of each phase on the level of each risk

Project phases/ Technical-operational risk factors	r=1	r=2	r=3	r=4	r=5	r=6	r=7	r=8	r=9
f=1	0.257	0.103	0.316	0.254	0.387	0.178	0.466	0.089	0.084
f=2	0.514	0.413	0.632	0.761	0.619	0.535	0.559	0.535	0.585
f=3	0.772	0.619	0.527	0.338	0.542	0.624	0.653	0.713	0.669
f=4	0.257	0.516	0.422	0.254	0.387	0.535	0.187	0.356	0.418
f=5	0.086	0.413	0.211	0.423	0.155	0.089	0.093	0.267	0.167

Table 6. The aggregated value of adaptive capacity of each phase on the level of each risk

Project phases/ Technical-operational risk factors	r=1	r=2	r=3	r=4	r=5	r=6	r=7	r=8	r=9
f=1	0.381	0.389	0.314	0.778	0.389	0.645	0.254	0.381	0.381
f=2	0.254	0.389	0.627	0.259	0.259	0.323	0.381	0.254	0.381
f=3	0.381	0.778	0.627	0.389	0.778	0.645	0.762	0.762	0.762
f=4	0.254	0.259	0.314	0.389	0.389	0.215	0.381	0.381	0.254
f=5	0.762	0.156	0.125	0.156	0.156	0.129	0.254	0.254	0.254

The vulnerability of each project phase (Step 3 of the proposed Algorithm) for each risk is calculated and by illustrating developed procedure on example of vulnerability of phase one on risk r=1:

$$\tilde{V}_{11} = s_{11} \cdot e_{11} \cdot a_{11} = 0.450 \cdot 0.257 \cdot 0.381 = 0.044$$

Vulnerability of phase one with respect to all identified risks is given:

$$\tilde{V}_1 = \frac{1}{9} \cdot (0.044 + 0.010 + 0.011 + 0.044 + 0.052 + 0.014 + 0.013 + 0.014 + 0.012) = 0.2138$$

The vulnerability of all other phases is calculated and determined its rank. It is presented in Table 7.

Table 7. *The vulnerability of each project phase and their rank*

Project phases	V_f	The rank
f=1	0.2138	2
f=2	0.0962	3
f=3	0.2614	**1**
f=4	0.0445	4
f=5	0.0203	5

By application of the proposed model it is calculated that the most vulnerable phase of the project implementation is the executing phase. Based on the results of real life practice, it may be concluded that the obtained result is expected. This may be explained by the fact that this phase is impacted by the greatest influence of risk factors. The rank of vulnerability related to each phase is obtained, it leads to decreasing time, costs and other resources that are needed for enhancement of project management practice activities in this state, the project may be realized but some measures for decreasing and managing vulnerability would be applicable.

5. CONCLUSION AND RESEARCH IMPLICATIONS

The project management represents very important part of business activities within many organizations. Serious problems in organizations may arise from untreated vulnerability which eventually may lead to overall business collapse or even a catastrophe.

The main practical implication of the proposed qualitative approach is dominantly focused on graphs which are used as visual maps that facilitate the understanding of vulnerabilities by analyzing supply side, demand side and supply infrastructure. In that way, management team is able to make important decisions, work towards decreasing project's vulnerability or even stop the project's realization.

The main contributions of the proposed model are further discussed: (1)a tool for assessment of project management vulnerability in reverse supply chain is obtained in well-structured manner and described by mathematical model (this is important since this approach supports obtaining a solution by an exact method); (2) the assessment is performed in the planning stages before its realization so it could be managed; (3) all the possible changes, such as number of treated risks can be easily incorporated into the model.

The main constraints of the proposed model are related to the scope of model since it covers the vulnerability that originates from technical and technological risks. Also, there is a need for structured project management practice which is in compliance with PMBOK Guide. Taking in account contributions and the main constraints of the model, it may be concluded that it represents solid base for further development of quantitative approaches in the project management vulnerability assessment.

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Acknowledgment: Research presented in this paper was supported by Ministry of Science and Technological Development of Republic of Serbia, Grant TR 35033.