Computers & Industrial Engineering 72 (2014) 98–105

Contents lists available at ScienceDirect

Computers & Industrial Engineering

journal homepage: www.elsevier.com/locate/caie

Modeling and risk analysis of virtual project team through project life cycle with fuzzy approach

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ARTICLE INFO

Article history:
Received 23 August 2013
Received in revised form 22 February 2014
Accepted 25 February 2014
Available online 15 March 2014

Keywords:
Virtual project team
Risk analysis
Risk management
Project life cycle
Fuzzy set

ABSTRACT

The ongoing revolutions in e-business and progresses of IT and communication, has resulted in the increasing number of companies with formal virtual project teams. In such situation, Uncertainty analysis gains more importance, being conducted within risk management framework. In this paper, based on the six phases of risk management procedure in PMBOK methodology, a risk management process in virtual projects is introduced. In qualitative analysis phase (of PMBOK methodology), the most effective factors of project management in virtual project teams are prioritized. In quantitative analysis phase, for the very first time, "Fuzzy Linear Programming Model" is employed to assess project risks based on project life cycle. Also given time and budget constraints, a method for developing appropriate strategies of reacting to each risk factor is introduced. We use GAMS (General Algebraic Modeling System) to select these strategies. Finally, we test our model in a numerical example, as evidence.

1. Introduction

According to Luse, McElroy, Townsend, and DeMarie (2013), virtual teams (VTs) are characterized as a group of people with unique skills who work interdependently but are separated geographically and they need technological mediums to communicate. Thus, virtual teams allow members to accomplish specific tasks while transcending traditional restrictions of time and proximity. Consequently, VTs differ from classic teams which people are physically concentrated in one place. In VTs, members are physically separated from one another and they rely on technological devices for communication and information exchange. Project-based industries such as Architecture, Engineering and Construction are becoming more globalized as firms seeking to access specialized knowledge from all parts of the world. Gartner group (www.gartner.com) predicts that, by 2004, more than 60% of the professional workforces in the Global 2000 Companies will most probably work in virtual teams. By 2003, half of the existing VTs failed to meet either strategic or operational objectives due to inability to manage geographically distributed workforce (Iorio & Taylor, 2013). The concept of Dynamic Risk Management in virtual projects, which can be implemented according to project life cycle, is a new concept. In the model proposed in this paper, in order to apply dynamic risk management, project manager must repeatedly evaluate risk factors at the end of each phase or before big changes, and if necessary, s/he must apply suitable strategies for the next phases.

In the literature of risk management and project life cycle, risk reaction strategies are barely discussed. For example, Xie, Zhang, and Lai (2006) introduced different periods of project life cycle in software projects then they determined risk factors and finally, according to project life cycle theory, they calculated total amount of project risk. In addition, Liu, Zhang, Zhang, and Zhou (2007) proposed a fuzzy risk analysis model in order to calculate total amount of project risk, they assigned risk factors to different periods of project life cycle.

We have managed to identify strategies for effective management of these critical issues in VTs at a fine-grained level that prior studies using survey measures of generalized conflict management types have not achieved. Consequently, in order to fulfill this shortcoming, according to PMBOK methodology and considering risk factors and risk assessment systems in virtual project life cycle, we decided to articulate all the phases of risk management of virtual projects in one new model. Pervious mathematic programming models in virtual projects' risk management are categorized in three classes: (1) without constraints, (2) with time constraint, and (3) with budget constraints, where time and budget constraints are definite values. In our model, since we cannot provide an appropriate risk reaction strategy based on merely budget

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http://dx.doi.org/10.1016/j.cie.2014.02.011
0360-8352/

constraint without considering time limitation, time and budget constraints are applied simultaneously. Furthermore, according to the virtual projects' concepts we must use fuzzy values for budget and time of risk reaction strategies.

There are many similarities between virtual project teams and classic project teams. In other words, a virtual project team and a classic project team are directed toward similar results. Moreover, basic project management methodology for both is the same, meaning that, whether the project team is gathered together in one building or is not centralized in a specific workplace, the fundamental procedures are the same (Trautsch, 2003). However, in contrast with classic project management methods, a virtual project requires more efficiency of cooperation between members of the project team. Ayok, Konrad, and Boyle (2012) stated that one major difference in the conflict in Face-To-Face Teams (FTFTs) and virtual teams (VTs) is technology and the lack of opportunity for face-to-face cues and interacting are major sources of conflict in VTs.

Classic project management standards are based on the fact that the project can be managed by a predefined plan (Zigurs, 2003). However, in virtual project teams, plans must be updated and decision making must be shared with team members, and a more important distinction, in comparison with classic project teams, is that nothing should be hypothesized. Therefore, Management challenges increase in virtual projects. Therefore, Aldeaa, Popescua, Draghicia, and Draghicib (2012) underlined that VTs have the same problems as traditional teams, but they face new challenges. At the same time, VTs have the potential to achieve further benefits in processes and provide high quality solutions by assembling people with different types of knowledge and expertise. Members of virtual projects do not see each other face to face and for this reason; the cooperation in these teams may abate (Vaslet, 2008). Timing and scheduling in virtual projects, due to several complexities such as separate work places and different cultural backgrounds, are other obstacles that impede the process of defining and articulating project management goals. Managing a virtual team is about managing the whole communication strategies and performing project management technics.

2. Virtual project life cycles

Project life cycle entails a set of steps, which are critical for achieving project goals. Liu et al. (2007) defined four periods for virtual projects' life cycle (Fig. 1). Steps of this life cycle are: recognition period, construction period, operation period, and ending period. These periods are discussed briefly as follows.

Recognition period: this is the beginning of the project. The main objectives in this period are recognition, evaluation, and selection of opportunities in the business market.

Construction period: this period includes determining and selecting work force, designing project structure and designing information and communication systems.

Operation period: in this period, resources and expenses are monitored, project processes are conducted and management risks are analyzed.

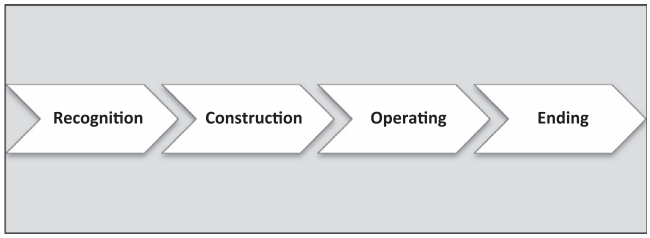

Fig. 1. Periods of virtual project life cycle of Liu et al.

Ending period: disengaging project team members and terminating processes of virtual project take place in this period.

We use this classification in this paper in defining periods of virtual project life cycle.

2.1. Managing fuzzy models

For modeling uncertainty in project management, using fuzzy sets is a better solution. Considering the fact that most of the data about risk recognition are gathered from experts' notions, it would be more beneficial to model these data within fuzzy context (Söderlund, 2004). Marhavilas, Koulouriotis, and Gemeni (2011) show most of popular risk analysis methods just rely on probability theories and operational research methods introduced in 1950s. Those methods cannot utilize implicit and imprecise information, which are gathered from experts and professionals' viewpoints in unauthorized ways. From the other hand, due to low repeatability in most events pertaining to virtual projects, this is not reliable to merely use probability methods. Fuzzy models can be classified in four general classes; without time and budget constraints, only with time constraint, only with budget constraint and with both time and budget constraints. Each of which can be analyzed in a number of conditions: certain time and fuzzy budget, fuzzy time and certain budget, and fuzzy time and fuzzy budget.

3. Modeling risk management in virtual project

Considering pros and superiorities of PMBOK methodology in providing a risk management framework, we discuss implementation process of virtual project risk management according to this methodology. Risk management process in PMBOK methodology is discussed in six phase: Planning Risk Management, Identifying Risks, Performing Qualitative Risk Analysis, Performing Quantitative Risk Analysis, Planning Risk Responses, Monitoring and Controlling Risks (PMBOK® Guide, 2008).

3.1. Risk identification in virtual projects

The most important risk factors, which affect virtual projects, are identified in papers and researches during 2000–2012. Factors that are discussed in just one or two researches are not considered in this paper and we merely deal with those factors, which are discussed and repeated in more than five researches, as virtual project risk factors. We focus on risks stemmed from management shortcomings and in order to avoid intricate issues, we do not handle certain hazards of projects.

The factors below are ordered by the emphasis they have received in the literature and researches so far:

1. Insufficient communication: This factor discusses the shortcomings of communication in project team, which cause adjournments in conducting activities and less quality in doing project activities. In fact managing the communication between members of the team is as important as the relation between the organization and other establishments such as suppliers and customers.
2. Mistrust: lack of mutual trust among virtual team members.
3. Lack of commitment: lack of commitment of team members because of bad monitoring or low job security.
4. Lack of cooperation and coordination among team members: the objective is transforming personal knowledge to organizational knowledge. This objective requires designing an environment where all the people feel comfortable (and are motivated) to share their knowledge.