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ScienceDirect

Procedia Computer Science 64 (2015) 24 – 31

Procedia
Computer Science

Conference on ENTERprise Information Systems / International Conference on Project MANagement / Conference on Health and Social Care Information Systems and Technologies, CENTERIS / ProjMAN / HCist 2015 October 7-9, 2015

Project risk time management – a proposed model and a case study in the construction industry

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Abstract

This paper proposes a mathematical model supporting the management of project risk. The model distinguishes between risks which have to be accepted and risks which can be eliminated at some cost, helping to decide which risks should be eliminated so that the customer requirements with respect to project completion time can be satisfied at minimal cost. The model is based on a modification of the PERT method and can be reduced to a mixed linear programming problem. The model is illustrated by means of a real world case concerning a construction project.

Peer-review under responsibility of SciKA - Association for Promotion and Dissemination of Scientific Knowledge

Keywords: project time management; risk elimination; PERT method.

1. Introduction

The execution of construction investments is a very complex endeavour. It is linked to many potential risks (here, we understand risk as an event which may happen and if it does, will have a negative influence on project success[16]; in this paper we emphasize the time aspect of project success). The construction process is a chain of events depending on the efficiency and capacity of the people and the equipment, on the weather, the site and policy conditions, on the

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Peer-review under responsibility of SciKA - Association for Promotion and Dissemination of Scientific Knowledge
doi:10.1016/j.procs.2015.08.459

attitude and influence of numerous stakeholders, etc. There are many serious risks that can significantly influence the completion time of construction projects and timeliness tends to be very important in such projects. The seriousness of construction project delays and the problem of avoiding them have been discussed thoroughly in the literature[1,12,17,20,22,23,24] and are addressed here in section 2, which provides a brief literature review on the subject.

Taking all this into account, it should be stated that in the area of construction projects, as in many other areas in which projects with significant uncertainty concerning duration are executed, it is necessary to conduct research into methods for scheduling such projects considering the risk of delay. Of course, such research has been conducted for many years. In this paper, however, we propose a new quantitative model, based on stochastic programming and on a modification of the PERT method, which differs from existing models in that it makes it possible to treat different risk categories in different ways; the existing models, to the knowledge of the authors, do not explicitly do so. The different treatment of various risk categories is important because some construction project risk categories may be more suited to one risk management approach at the given moment and in the specific situation, whereas other categories may suggest a completely different risk management approach. By referring to different risk management approaches, we understand, for example, risk avoidance, risk transfer, risk mitigation and risk acceptance[16]. In our model, we enable the incorporation of various risk approaches for application in the mathematical model.

The goal of the paper is thus to propose a new stochastic programing model which makes it possible to differentiate various construction project risk categories with respect to risk management treatment and to validate the model using a real world construction project case study. In Section 2 the state of the art (limited to the literature most significant to the paper) on construction project risk categories and on stochastic PERT-based models concerning project risk management is presented. In Section 3 the new model is proposed and in Section 4 the case study is analysed. The paper ends with conclusions.

2. State of the art

2.1. Risk categories in construction projects

In the literature, risks in construction projects are divided into different categories. This process enables grouping of risk areas, at the same time improving the transparency of analysis. In the literature, there are different proposals for risk categorization. For example in the International Construction Risk Assessment Model (ICRAM)[7], a division into three major categories of risk is proposed: risk at the macro level, risk involved in the construction market and risk at the project level. In the first category the following groups are distinguished: operational risks, political risks and financial risks. In the second category there are technological risks, legal risks, cultural risks and risks of changes in market potential. In the last category, the model considers project management risks, technological risks, disaster risks, financial risks, contract risk, quality risks and weather risks. It is worth mentioning that each of these sub-categories is divided into further categories of risk, which in turn facilitates the building of a precise and transparent risk map.

Skorupka[19] also divides risks into categories. In this case, these are linked to the phases of the investment process in the construction industry and include: preliminary design, tender, detailed design, construction and settlement of payments. For example, in the first phase, the author distinguishes the following types of risk: risks of poorly recognized competition, risks of poorly recognized investor preferences and risks of underestimating the project costs.

Other authors[1] propose nine categories of risks: risks associated with the project, risks associated with the owner, contractor-related risks, risks associated with the consultant, risks associated with the design team, risks associated with materials, hardware-related risks, risks associated with the labour force and external risks. For instance, the first category includes risks such as too short a period stipulated in the contract, legal disputes between the different parties, inadequate definition of the facts, ineffective penalties in the case of delays in the project, a wrong order type and a wrong bid type. We also find another approach[24]: the division of risks into cost-related, time-related, quality-related, environment-related and safety-related aspects. For example, risks associated with costs are: tight project schedule, design changes, changes of investor, improper construction planning, conflicts, changes in prices of materials, complexity of licensing procedures, incomplete documentation, imprecise estimates and misdistribution of work.