

2012 International Workshop on Information and Electronics Engineering (IWIEE)

Multi-Objective Ant Colony Algorithm in EPC Risk Control

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Abstract

According to the risks and risk control target in energy performance contracting (EPC), this paper has designed the risk control measure set. On the basis, a risk control model is put forward, including the risk evaluation, risk control cost, risk loss. Then, a multi-objective ant colony algorithm, based on Pareto theory, is used to solve the model. A series of Pareto optimal solutions are got by example. The result shows that the solutions have the better diversity and convergence. At the same time, the model can find the best combination of various risk control measures in EPC, which can provide direct evidence for the company of EPC.

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Keyword: Multi-objective optimization; Pareto optimal; Ant colony algorithm; Energy performance contracting

1. Introduction

EPC is a commercial operation mode of EMC, which company can provide energy saving technology and services for some customers by signing energy service contracts with the customer, ensure the realization of contract promised amount of energy and energy efficiency, take back investment and obtain profits from the customers' benefits gotten after energy saving renovation. EPC is widely used in higher degree of market of developed country. In the last century 90's, EPC is introduced into China. But it is not developed quickly. The reason is that the risk management ability of energy service company in China is not worth badly at present.

At present, many scholars make a study on EPC risk from the different viewpoints. K.H.Ng et al. studied the risk value and risk aversion of EPC project in energy service company[1]. Evan Mills et al.

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made a deep analysis on EPC risk by energy saving insurance transfer[2]. Gerald B. Sheble et al. established risk probability model and estimation principle method of energy service company by mathematical methods[3]. Evan Millsa put forward the analysis framework for the funds and risk of EPC projects, and made accurate analysis on existed risk by energy experts and investment experts' experience and knowledge[4]. T.C. Shang et al. discussed the evaluation index system of EPC project risk in China, and made quantitative evaluation on risk by using fuzzy comprehensive evaluation[5]. According to above documents analysis, the study on EPC risk has not effective control measures currently. Thus, in order to provide direct decision basis for contract energy project managers, the risk control model of EPC is established to find optimal control measures in this paper.

2. EPC Risks and Its Control Measures

2.1. EPC risk analysis

The core of EPC is energy saving service company, which risk comes from EPC inner. This risk has important effect on EPC's success or failure, and is an internal variable influencing on EPC mode operation performance. In the light of the current situation of EPC in China, the EPC risk is divided into management risk, human capital risk, system risk, credit risk, business risk, customer risk, coordination risk, implicit cost risk, market risk and performance risk.

Table 1. The risks in EPC

The risk in EPC	Sign	Influence factor	The risk in EPC	Sign	Influence factor
Management risk	R_1	Imperfect management system	Customer risk	R_6	Customers' understanding to major issues
		Management pattern difference of both sides			Improper customer selection
Human capital risk	R_2	Management backwardness	Coordination risk	R_7	Communication barriers
		Human capital mobility			Low trust
System risk	R_3	Human capital value uncertainty	Implicit cost risk	R_8	Ignoring finding cost
		Human capital initiative			Surrounding environment cost
Credit risk	R_3	Imperfect system	Market risk	R_9	Technology dissemination cost
		Hidden measure			Market uncertainty
Business risk	R_5	Intentional bankruptcy	Performance risk	R_{10}	Fluctuation of market price
		Energy saving benefit transfer			Finance and financial management
		Client default			Design and technology
		Operation management mistakes			Equipment and raw materials purchase
		Embroided in a legal dispute			Engineering construction
		Engaged in illegal business			

2.2. Establishing the risk control measures set in EPC

According to the risk characters of EPC, the risk control measures of this phase are divided into two sets in this paper, including main and auxiliary risk control measures. Among them, the main risk control measures refer to the measures adopted in practice after induction, which can solve some important risks by relative systematic and comprehensive way, and play an important role in mitigating risk. The

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