Energy Policy 97 (2016) 559–581

Contents lists available at ScienceDirect

Energy Policy

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

AHP-based risk analysis of energy performance contracting projects in Russia

Maria Garbuzova-Schlifter*, Reinhard Madlener

Institute for Future Energy Consumer Needs and Behavior (FCN), School of Business and Economics / E.ON Energy Research Center, RWTH Aachen University, Mathieustrasse 10, 52074 Aachen, Germany

HIGHLIGHTS

- AHP- and survey-based study of energy performance contracting (EPC) projects in Russia.
- Main risk factors and causes of risk associated with EPC projects are investigated.
- In practice, lack of a feasible risk management approach in EPC projects.
- Regulatory and financial risks contribute most to the EPC projects' riskiness.
- Elaboration of the sector-specific EPC project contractual scheme is required.

ARTICLE INFO

Article history:
Received 1 September 2015
Received in revised form
13 July 2016
Accepted 14 July 2016
Available online 13 August 2016

Keywords:
Risk analysis
Energy performance contracting
Energy service company
ESCO
Russia
Analytic hierarchy process

ABSTRACT

Understanding and properly managing risks that could potentially affect the target- and performance-based profits of energy performance contracting (EPC) projects are essential. It is particularly important for the establishment and success of energy service companies (ESCOs) acting in the vulnerable environment of the vast but highly energy-inefficient Russian market. This study systematically explores common risk factors and causes of risk associated with EPC projects executed in three Russian sectors: (1) industrial; (2) housing and communal services; and (3) public. Several interviews with the Russian EPC experts were accomplished and a qualitative risk assessment by using an analytic hierarchy process (AHP) approach. The data were obtained from a web-based questionnaire survey conducted among Russian EPC project executors. For each focus sector, a specific preference-based ranking of the identified risk factors and causes of risk was derived. The AHP results show that causes of risk related to the financial and regulatory aspects contribute most to the riskiness of EPC projects performed in all three focus sectors in Russia, calling for the special attention of EPC policy- and business-makers. Due to sectorial particularities and different actors involved, we conclude that there is a need for elaboration of sector-specific contractual schemes for EPC projects.

1. Introduction

Energy Performance Contracting (EPC) can become the key vehicle for the aspired energy- and carbon-efficient technical modernization of the Russian economy. A contractual form EPC was introduced in Russia in 2009 by Federal Law No. 261-FZ "On Energy Saving and Energy Efficiency Improvement and on the Introduction of Amendments to Certain Legislative Acts of the Russian Federation" (hereafter "Federal Law No. 261"). EPC projects in Russia can be executed either by Energy Service Companies (ESCOs) or other types of energy service providing companies (ESPCs)[1] (Garbuzova-Schlifter and Madlener, 2013). The estimated potential of the Russian EPC market amounts to about €8.45 bn per year and the expected investments have been calculated to sum up to about €59.1 bn by 2015 (GISEE, 2013).[2] However, in spite of promising expectations, under the vulnerable market, economic,

[1] In this paper, we refer to the term "ESPCs" as an umbrella term that encompasses several types of companies (e.g. outsourcing energy management, energy retail, energy audit) that may perform EPC projects in parallel to ESCOs in Russia. For simplicity reasons, we only refer to ESCOs, implying ESCOs and ESPCs are synonymous, unless we explicitly differentiate between these two types of company.

[2] 1 RUB = €0.0169 on November 17, 2014 (OANDA, 2014).

* Corresponding author.
E-mail addresses: MGarbuzova@eonerc.rwth-aachen.de, mgarbuzova@eonerc.rwth-aachen.de (M. Garbuzova-Schlifter), RMadlener@eonerc.rwth-aachen.de (R. Madlener).

http://dx.doi.org/10.1016/j.enpol.2016.07.024
0301-4215/

and political conditions, the EPC market is evolving so far rather slowly in Russia. The awareness regarding the EPC concept is limited and most banks rank EPC projects as a high-risk investment.

In line with EPC projects that are complex projects of an interdisciplinary character, ESCOs install appropriate energy conservation measures at the client's site and guarantee the project outcome in terms of the maximum energy savings achieved at lowest possible costs. The spectrum of project risks that ESCOs face varies from technical and performance risks, to – depending on the form of the underlying contract – investment and financial risks. For ESCOs it is critical to be aware of any potential risks that could negatively affect the targeted performance-based profits and effectively manage these (mitigate, transfer, or, if possible, eliminate) (Hansen, 2006; Mills et al., 2006).

Practical experience shows, however, that EPC projects often underperform and most experts use solely a "rule of thumb" to analyze project risks (Heo et al., 2011). Some international studies constitute the first attempts to identify and classify some of the risks associated with EPC projects (e.g. Cook and Bradford, 2012; Lee et al., 2013; Mills et al., 2006; Sheblé and Berleant, 2002). Although some EPC project risks can be considered common for ESCOs among the countries, others depend on the specific country's business environment, regulations, and contractual procedures.

The overall aim of this paper is to systematically investigate and provide a general risk framework that Russian ESCOs commonly face. More specifically, we seek to identify, classify, and rank the main risk factors and causes of risk in terms of their contribution to the riskiness of an EPC project. The focus is thereby put on three distinct sectors of the Russian market (hereafter "focus sectors"), where most EPC projects up to now have been executed: (1) industrial; (2) housing and communal services focusing on multi-family apartment buildings (MFABs); and (3) public.

In essence, the project risk management process consists of two phases: (1) *risk analysis* that aims at understanding potential risks and prioritizing them, and (2) *risk management* that tends to mitigate impact of risks on the project goals (Chapman, 2001). The research done is restricted to the *risk analysis* phase that includes *risk identification* and *risk assessment*. Risk identification is the most important process, as only identified risks can be managed. In this study, this process was approached in a comprehensive manner by means of (1) investigation of the existing body of international literature on risks associated with EPC projects; (2) analysis of the EPC conclusion procedure in each focus sector in Russia; (3) validation of the identified risks specifically for the Russian ESCO market during the semi-structured interviews with the Russian EPC experts, and decomposition of the final set into risk factors and causes of risk.

Project risk assessment can basically be performed by using two main approaches: quantitative and qualitative. A quantitative approach embraces a variety of techniques such as Monte Carlo simulation, sensitivity analysis, fault tree analysis, event tree analysis, and others. These techniques, though, require sufficient quantitative (historical) data to perform statistical analysis in order to obtain the objective probabilities and frequencies enabling evaluation of risks (Ahmed et al., 2007; Kangari and Riggs, 1989). For cases where such data is not available or imprecise, a qualitative approach based on subjective judgments (expert opinions) should be used. It involves techniques such as the probability and impact grids, decision tree analysis, multiple criteria decision-making (MCDM) methods, and others (Ahmed et al., 2007). Even though, the obtained results are linked to expert preferences and expertise and, hence, can be individually biased, the qualitative methods provide "[…] a basis for risk assessment where it is more important to highlight risk events that are possible, rather than an exact prediction […]" of their occurrence (Ahmed et al., 2007, p. 28).

For the purpose of this study, we performed a qualitative risk assessment using the analytic hierarchy process (AHP) method, one of the MCDM methods. The data was elicited through a web-based questionnaire that was disseminated among experts who execute EPC projects in different sectors and regions in the Russian market. Developed by Thomas Saaty (Saaty, 1980), AHP is now one of the most widely and frequently used methods to resolve complex MCDM problems in diverse research areas,[3] including qualitative risk assessment across a great variety of applications (e.g. Brent et al., 2007; Deshmukh and Millet, 1999; Fazli and Mansourdehghan, 2012; Sturk et al., 1996; Tsai et al., 2008). AHP breaks down a complex decision problem into a hierarchical structure. Through pairwise comparisons between the criteria of a hierarchy, experts are then asked to provide their subjective judgments (preferences) on the dominance of one criterion over another in order to determine their relative importance for a defined goal.

Unlike other MCDM methods, such as e.g. multi-attribute utility theory (MAUT), AHP is less data-intensive and can be more easily applied to solve decision problems with limited data. AHP does not assume that the decision-makers are rational as it is the case for MAUT and tolerates some level of inconsistency in their judgments, which is the case for most real-life decisions (Linkov et al., 2007). Moreover, AHP deals with quantitative and/or qualitative criteria, even though some of these cannot be measured by "standard scales" and developing quantifiable measures has proved to be difficult (Chelst and Canbolat, 2012; Davies, 2001). Notice also that the difference between AHP scales and simple Likert scales is that the preferences are elicited for two criteria at the same time, while the Likert scale rates only one criterion at a time (Kendrick and Saaty, 2007). For humans, according to Saaty (2006), making relative judgments through such pairwise comparisons is more "natural" than providing absolute ones.

Importantly, AHP is a non-statistical method, hence, it does not set any requirements on the sample size (Duke and Aull-Hyde, 2002). At the same time, it allows for synthesis of the individual priority settings on criteria that might be elicited from a group of experts. As such, experts can be located in one place or geographically dispersed, and they can act as "one individual" or incorporate different value systems (Davies, 2001; Forman and Peniwati, 1998). Overall, AHP increases the transparency of the decision-making process and captures both subjectivity and the necessary objectivity by delivering plausible results (Davies, 2001; Dey, 2001; Parra-López et al., 2008).

Nevertheless, a number of extensive debates on the shortcoming of the AHP method has emerged in the scientific community (e.g. Belton and Stewart, 2002; Gass, 2005; Smith and von Winterfeldt, 2004). The main issues include (1) *rank reversal*; (2) *the fundamental 1–9 ratio scale and exclusion of "zero" from this scale;* (3) *the eigenvector method*; (4) *the transitivity issue;* (5) *inconsistency in judgments*. Most of these issues were addressed by T. L. Saaty in the scientific discussion and have since been refuted. However, AHP calculations do present the issue of inconsistency in judgments, and this was thus handled in this study by using two mathematical methods: (1) the *Maximum Deviation Approach (MDA),* proposed by Saaty (1980, 2003) and so named by Gastes and Gaul (2012), and (2) the *Induced Bias Matrix Model (IBBM),* recently developed by Ergu et al. (2011) and Kou et al. (2013).

For the purpose of this paper, the following working definitions have been adopted: A *risk factor*, which is triggered by one or more

[3] A comprehensive review of the application fields of the AHP method can be found in Shim (1989), Vaidya and Kumar (2006), and Zahedi (1986).