Green vendor evaluation and selection using AHP and Taguchi loss functions in production outsourcing in mining industry

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ABSTRACT

The fast growing demand of minerals due to increasing level of consumption has got the mining industries focus on developing and developed countries. Generally mining and mineral operation is an excellent contributor to economic growth and development in each country. Presently in many countries, the mining sector intends to augment their production operation with private participation due to the challenges that they are facing like, cost reduction, improving capital project management, employee management, environmental impacts, enhancing corporate social responsibility, global economy crisis, etc. The benefits of outsourcing are not only reduced cost in operations but also increased productivity and efficiency, accessing the relevant technical experts, implementation of the latest technologies like green technologies for green mining and ultimately increase in profit. Moreover, the mining industries receive significant global attention due to the nature of their environmental and social responsibilities, and it is necessary for the mining sector to turn their operation towards green practices. The proper vendor selection for production outsourcing may bring the solution to the challenges faced by the mining industries. The vendor selection in mining industries depends on varieties of conflicting tangible and intangible criteria and this paper deals with the suitable vendor selection for the production process in the green mining industries based on economic and environmental benefits and risk factors. This paper proposes a model frame work with case study through the combined approach of analytic hierarchy process (AHP) and Taguchi loss functions. The proposed method is used to measure the loss due to the outsourcing vendor performance for the pertinent benefit and risk factors and identify the best vendor to perform an outsourcing function in the mining industry production.

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Introduction

The mining sector is a major contributor to the economic development in many countries and it is normally undertaken by the government. The mining sector covers broad range of activities in their operation such as financing, planning, marketing and labour relation on the soft side, and exploration, excavation, production, material handling, processing and refining on the physical side, and management of all these activities (Stacey et al., 1999). In recent years, the mining sector faces some challenging environmental issues in their supply chain such as the noise and dust pollution due to top-soil disruption, water and air pollution, chemical hazard, global warming due to greenhouse gas emissions (Vintró et al., 2014; Sousa et al., 2011; Muduli et al., 2013). Muduli et al. (2013) specified that improper planning and

controlling of mining activities would cause serious environmental impacts in the mining sector. Hence, the mining sectors are presently focused on the green production in their activities and they show interests in outsourcing their core activities to meet the challenges. Moreover, mining sector prefers the outsourcing not only for cost reduction, but to improve their focus on industry core competencies such as finance, marketing, investment and environmental management (Heili, 2005).

Generally, the reasons for outsourcing business activity are cost reduction, adding expertise, comprehensive services, continuous improvement, to sharpen the strategic focus of core company (Embleton and Wright, 1998; Lankford and Parsa, 1999; DeRose and McLaughlin, 1995; Ahmadi and Kantardjian, 2012; Kassem and Dawood, 2013). Currently, the outsourcing has become a major corporate trend in mining sector internationally because the proper use of outsourcing can boost the performance in cost reduction, productivity growth, profitability increase and value improvement (Campbell, 1995; Zhu et al., 2001). Outsourcing has been used in non-core activities like cleaning, catering and security

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of mining industries since a number of years; and presently it is used in the core activities of mining industries. The mining activities which are outsourced nowadays are drilling and blasting; equipment performance checking and regulatory monitoring; warehousing and, maintenance and service (Peterson et al., 2001). According to Sanders et al. (2007), outsourcing involves executing the task, the process or production activity to earn considerable benefits through selecting a private partner or supplier or service provider. Elliott (1996) defined outsourcing of professional services in the mining industry as partnering or the external provider selection concept in the contract mining area. Moreover, inefficient outsourcing vendor may create problems for the core company like improper supply, production loss, environmental incidents, and fatal incidents in the production plant. Hence, the outsourcing vendor selection needs careful thought because outsourcing will be vulnerable due to poor performances of the external service provider (Stacey et al., 1999) and the contextual criteria should be considered in outsourcing vendor selection, such as capability, cost, technology, supply and product market conditions (Jennings, 2002); benefit and risk analysis, cost analysis, environmental analysis, demand and supply analysis, competitive advantage analysis (Fill and Visser, 2000); shared values, reputation, financial stability, experience, human resource policies and procedure (Stacey et al., 1999). According to Peterson et al. (2001), the benefits of outsourcing the mining activities are reduction in operations and maintenance of labour cost; reduction in maintenance facility and overhead costs; predictable expenditure in maintenance; facilities to include necessary high technologies which are not available locally.

Selection of appropriate vendor is the primary success of each outsourcing decision and they become a value-added partner in the business activity (Datta et al., 2013). In literature, numerous studies have been done on traditional vendor selection using single approaches and integrated approaches but limitedly in green vendor selection (Govindan et al., 2013). Also few researchers have studied the barriers, pressures and drivers in the implementation of green supply chain management based on procurement, vendor/supplier selection activities (Govindan et al., 2014; Mathiyazhagan et al., 2014; Azevedo et al., 2013). Various decision making models and techniques are developed comprehensively and effectively for the vendor selection problem which consider several factors/criteria. Ho et al. (2010) conclude in their review that AHP and goal programming (GP) approach are most popular for vendor selection. Some researchers have addressed the vendor selection issues in green management by using AHP (Noci, 1997; Lu et al., 2007; Chiou et al., 2008), fuzzy AHP (Lee et al., 2009), analytic network process (ANP) (Hsu and Hu, 2009; Büyükozkan and Çifçi, 2011), mathematical programming (MP) (Yeh and Chuang, 2011), AHP-GA (Yan, 2009), data envelopment analysis (DEA) and AHP (Wen and Chi, 2010). Pi and Low (2006) summarised the following vendor evaluation and selection techniques which are hardly covered in literature: categorical model (Willis and Huston, 1990), cost-ratio method (Dobler et al., 1996), cost-based method (Monczka and Trecha, 1988), vendor profile analysis (Thompson, 1990), dimensional analysis (Willis et al., 1993; Youssef et al., 1996) and Taguchi loss function method (Pi and Low, 2005). Azimi et al. (2011) apply SWOT analysis, ANP and VIKOR in the integrated way to evaluate the strategies in the Iranian mining sector. This paper introduces an integrated approach of AHP and Taguchi loss function for outsourcing vendor selection in mining industry production activities. AHP technique is extensively studied in literature as explained earlier in this section and it is used for evaluation and calculation of relative weights of decision factors in this study. Taguchi loss functions is applied in limited manner by researchers in the traditional vendor selection problem (Pi and Low, 2005, 2006; Liao and Kao, 2010; Ordoobadi, 2009; Magdalena, 2012) and it is used to determine the suitable green vendor for the outsourcing activity in this study by measuring the loss due to the performance

level of vendor for predefined selection factors. In this paper the following contribution has been made:

(1) The green vendor selection framework was developed for the outsourcing problem in a mining industry based on economic and environmental benefits and risk factors.
(2) This paper presents an integrated approach of AHP and Taguchi loss function which help the managers in the mining industry to develop green vendor evaluation and selection strategies to select suitable green vendor for their operation.

In this paper, Literature review section provides the literature review of outsourcing in the mining sector and green mining. The mining business models are presented in Mining business models section. The methodology for outsourcing vendor selection is explained in Outsourcing vendor evaluation and selection model section and the suggested approach is explained with case study in Case study: an illustration section. Result and sensitivity analysis section discusses the results of this study and sensitivity analysis. Finally, the managerial implications, conclusions, limitations, and future work are presented in Managerial implications and Conclusion sections.

Literature review

Outsourcing in mining sector

Heywood (2001) defined outsourcing as, assigning the business activity or assets to a third party or private partner or external vendor or supplier who provides the required service to complete the task or function in a defined time at an affordable price. Outsourcing in the mining industry has become a major corporate trend internationally. The main reason for outsourcing in the mining sector could be the desire to focus on core competencies like financing, investment and development, increase the productivity or service, and reduce the cost involved in the business (Gay and Essinger, 2000; Igarashi et al., 2013). According to Stacey et al. (1999), outsourcing is more common in many countries with mining industries and functions outsourced in mining industries are mine planning services, tailing dam design, shaft sinking and underground development, tunnel support installation, various aspects of environmental management and design, mining and back filling operation. Outsourcing of individual activities like labour sub-contracting creates complexities in mining operations (Kenny and Bezuidenhout, 1999). So, the mining industries prefer outsourcing of the entire mining operation for better productivity. Peterson et al. (2001) reveal that the outsourcing of complete mining operation is referred to as contract mining. The key success factors in mining outsourcing are access to technically skilled expertise, effective industrial relationship strategies, economics development opportunity, and holding long term contracts (HCI, 2012). Stacey et al. (1999) described the benefits of outsourcing in mining activities as innovative working, in-house quality control system, independent work management, reduced over heads, vendor replacement in case of poor performances, continuity in a long-term vendor relationship and the disadvantages are vendor is not available in full time, confidentiality in maintaining the mining records, mine may perceive that the unit cost for the vendor is high and mine may feel more vulnerable when the external provider does not share the risks of the mine.

Green mining

The series of environmental problem in the mining sector develops the new concept of green mining (Xu et al., 2007). Metal & Mining (M&M) sector is the environmental polluting and damaging sector in a