



Research on key techniques and hotspot migration of supplier selection and evaluation

Xiang Li, Huang Min Hao, Jia Huang

School of Economics and Management, China JiLiang University, Zhejiang Hangzhou, 310018, China

Corresponding author. Email: huangminhao1998@163.com

Abstract. Since suppliers are the starting point for influencing the value of a company's final product, evaluating and selecting suitable suppliers is an essential element of purchasing decisions. This paper uses bibliometric and inductive-deductive approaches to identify critical techniques and hotspots in supplier selection and evaluation. It is found that: (1) model-driven, knowledge-driven, probability statistics-driven, and data-driven are the leading technology categories for supplier selection and evaluation. (2) In terms of hotspot migration, the field of supplier selection and evaluation has gone through three stages: exploration period, active period, and blowout period, and "role change", "technology integration", and "green and low-carbon" are the core contents in this field. Moreover, the paper analyzes the tracks of development and practical effectiveness of supplier selection and evaluation.

Keywords: supplier selection; supplier evaluation; key technologies; hotspot migration; Citespace.

1 Introduction

In recent years, the rising cost of raw materials has made the position of suppliers more and more important. Supplier selection and evaluation is an important part of supplier management, and it contribute to efficient supply chain management and cost optimization.

Foreign scholars first began the research on supplier selection and evaluation in the 1960s. For example, Dickson [1] summarized 23 influencing factors of supplier evaluation through the case study, and suggested that quality standards and delivery capability play a vital role. After 1990, scholars began to introduce multivariate techniques to assist decision-making. Haq and Kannan [2] developed a new supplier evaluation and selection model by using AHP and GRA, which was used for supplier decision-making in the forward supply chain. Domestic research emerged at the beginning of this century. For example, Zhang et al. [3] proposed a data envelope model applying a preference constraint cone, which can reflect the psychological preference of decision-makers, and provides a new economic analysis method for suppliers' selection problems.

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Through analysis, it is found that most of the above studies were published before 2015, and most of them used qualitative or quantitative methods to classify related technologies. At the same time, there was a lack of research on the changing process of suppliers' roles, environmental requirements, application fields, and prospects.

Based on this, this paper intends to combine bibliometric analysis and inductive deduction, uses CiteSpace to identify the key techniques and hotspot migration in the field. The specific chapters are organized as follows: Part I discusses the research methodology and literature collection process; Part II summarizes the key techniques of supplier selection and evaluation and elaborates on their specific connotations; Part III identifies the research hotspots and migration process in the field.

2 Key technologies for supplier selection and evaluation

Based on the CNKI database in China, this paper selects 681 pieces of literature in the field of supplier selection and evaluation from 2001-2021, and uses CiteSpace' cluster analysis and burst algorithm to extract the domain knowledge structure groups.

This paper classifies supplier selection and evaluation techniques into the following four categories based on its intrinsic mechanisms: model-driven approach, knowledge-driven approach, probabilistic statistics-driven approach, and data-driven approach, as shown in Figure 1.

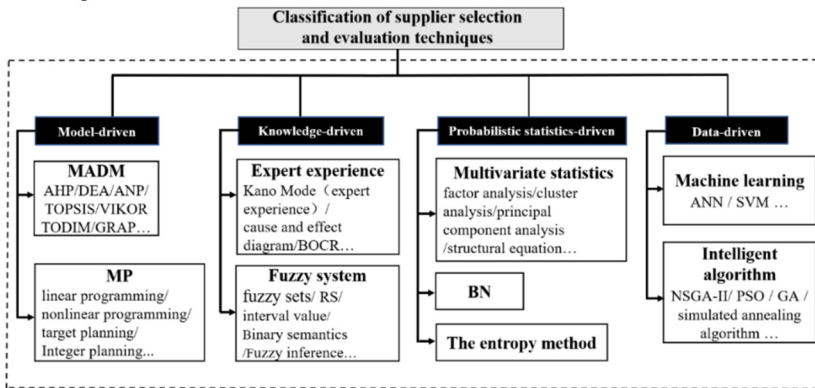


Fig. 1. Key techniques for supplier selection and evaluation.

2.1 Model-driven

(1) Multi-attribute decision-making (MADM).

In the existing research, scholars commonly used MADM include AHP, ANP, TOPSIS, VIKOR, and DEA. Among them, the widest range of research methods used for r supplier selection and evaluation is AHP, including 164 papers. AHP has the characteristics of high reliability and low error, and it is suitable for complex decision problems without a unified measurement [4]. However, this method is limited by the subjectivity of experts' evaluation and the uncertainty of decision preferences under uncertain decision preferences. Moreover, the utility function of AHP has incomplete

compensation, which cannot be applied to suppliers' decision-making in military supply, emergency operations and disaster relief [5]. ANP intuitively explains the non-obvious relationship between qualitative and quantitative indicators of supplier evaluation [6]. TOPSIS and VIKOR are ranking methods based ideal solution. TOPSIS is easy to calculate and doesn't require a large sample of suppliers, and it is less influenced by subjective factors [7]. In order to deal with the suppliers' decision problems, DEA introduces the concept of relative efficiency to evaluate the efficiency of input and output indicators [8].

(2) Mathematical programming (MP).

Many scholars consider suppliers' selection problems as multi-objective decision problems. Stochastic programming is used widely in the application of supply chain contract issues, but the solution is often ideal rather than certain [9]. Double-layer programming is used to establish game constraints among the trade of elements, but the solution process is more complicated due to the non-convexity of double-layer programming [10]. GA, SPEA2 have the advantages of fast computing speed and robustness, and they are often used to improve the reliability of supplier decision results combined with MP.

2.2 Knowledge-Driven

(1) Experts' experience.

In order to identify the best suppliers, experts' systems often use experts' scoring and deductive reasoning to evaluate and grade suppliers. Delphi uses anonymous way of communicating ideas to take experts' data, but the influence of the educational background of different experts is not considered [11]. Case reasoning determines the target supplier evaluation value by comparing the similarity of factors, such as the nature of the supplier's enterprise, size, and geographic location, but this qualitative way of describing comparisons lacks accuracy [12].

(2) Fuzzy system.

Fuzzy system covers fuzzy set theory, fuzzy logic, and fuzzy measure theory. Among them, fuzzy sets are the most widely used linguistic form for dealing with supplier evaluation information, it contains 110 relevant papers. RS is used to deal with the incomplete information of suppliers, which can achieve the minimum expression of knowledge information while retaining key information [13]. The fuzzy similarity priority ratio method identifies suppliers' advantages and disadvantages by comparing the similarity between multiple samples and a certain sample, which can effectively overcome the subjective influence caused by empirical dependence.

2.3 Probabilistic statistics-driven

(1) Multivariate statistics.

Multivariate statistics is used to study the statistical regularity among multiple

evaluation indicators in suppliers' decision-making. Among them, cluster analysis is used for supplier sample clustering without a priori information [14]. In addition, cluster analysis can also be used for the determination of experts' weights [15]. The principal component analysis can realize the mapping from high-dimensional data to low-dimensional space, and it can represent the original suppliers' data information with fewer data dimensions [16]. Exploratory factor analysis uses regression ideas to optimize the linear relationship between the comprehensive factors and the initial indicators of the suppliers' evaluation system [17].

(2) Bayesian network (BN).

BN constructs directed acyclic graphs and adopts data learning, experts' knowledge, or combination to deal with suppliers' risk assessment and decision-making under uncertainty [18]. BN can handle multiple uncertain random variables at the same time, and take into account the hierarchy and dependency between criteria. It is suitable for suppliers' decision-making like the development of complex production and other fields, but the reliability of the BN relies too much on experts' knowledge and experience, and incomplete information or the loss of observation data can make data learning difficult, which limits the application of the method [19].

2.4 Data-Driven

(1) Artificial Neural Network (ANN).

BP neural network has strong nonlinear mapping ability and flexible network structure, it contains 29 papers. Wavelet Neural network (WNN) and Radial Basis Function Neural Network (RBFNN) are improvements of ANN, which possess higher convergence speed and evaluation accuracy, and it can overcome the information redundancy problems among suppliers' evaluation indicators.

(2) Support vector machine (SVM).

SVM has very high prediction accuracy, and its classification models are often used to narrow the target space of candidate suppliers, but it is limited by the uncertainty of kernel function selection, and it relies too much on prior knowledge [20]. SVR is built on the basis of kernel mapping, which integrates the fitting error and function characteristics of regression models, it has good generalization capability, and has greatly improved the training accuracy and training speed for supplier samples [20].

3 A study of hotspot migration in supplier selection and evaluation

Based on the relevant literature published in 2001-2021, this paper uses CiteSpace to analyze the hotspot and evolution in this field. Figure 2 illustrates the knowledge structure clusters of supplier selection and evaluation. After filtering duplicate and invalid categories, 13 clusters are extracted.

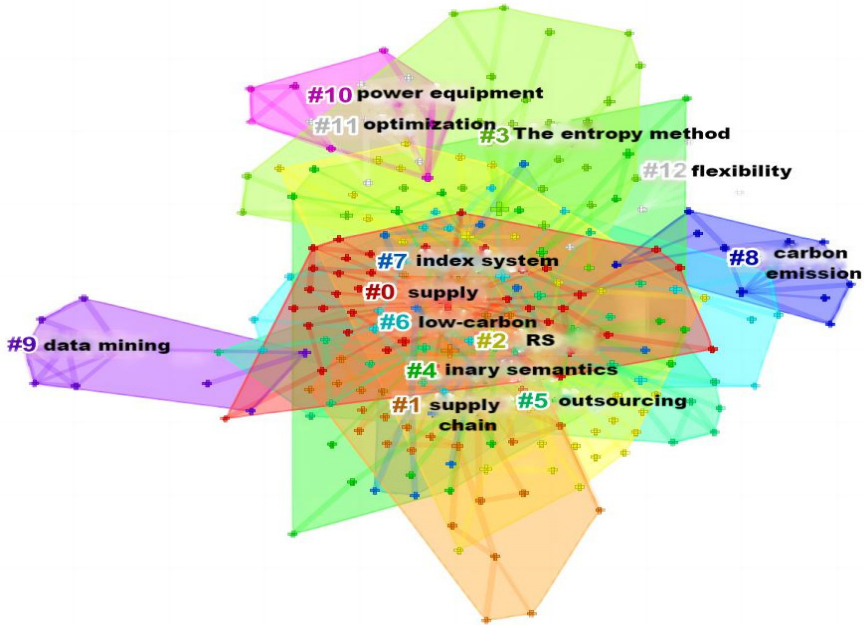


Fig. 2. Knowledge structure for supplier selection and evaluation.

This paper summarizes the development over the past 20 years into the following three stages: the exploration period (2000–2006), the active period (2007–2012), and the blowout period (2013–present).

3.1 Exploration period (2000–2006)

During this period, manufacturers and suppliers moved from a traditional trading relationship to a strategic partnership. Scholars discussed the characteristics and existing problems of suppliers in the context of the agile supply chain, global procurement and collaborative business, and they used many technologies such as AHP, goal planning, GRA, and DEA to realize suppliers' decision-making in the fields of auto parts, e-commerce, and railroad transportation [21]. In addition, the evaluation indexes are mostly based on quality, price, delivery capability and service.

3.2 Active period (2007–2013)

In this period, domestic scholars paid more attention to methodological research and theoretical applications, and they introduced knowledge-driven, probabilistic statistics-driven, and data-driven technologies into suppliers' decision-making. They are keen to study suppliers' decision-making in areas such as steel, library, logistics services and reverse logistics. And they think green supply chain is conducive to the sustainable

development of enterprises. In addition, data-driven techniques such as WNN, BP neural networks, and SVR were introduced for supplier decision making in this period.

3.3 Blowout period (2013-present)

The combined use of multiple methods became effective mean to improve the efficiency of suppliers' decision-making during this period. For example, the combination of subjective and objective techniques increased the reliability of weight determination [22]. The frequency of application of techniques such as binary semantics, trapezoidal fuzzy sets, and hesitant fuzzy sets had increased after 2013, and they can effectively characterize the uncertainty of experts' evaluation information. Based on "limited rationality", prospect theory considered risk preferences and psychological factors of decision-makers in supplier selection [23]. With the introduction of the double-carbon, energy saving and environmental factors need to be taken into account in suppliers' decision-making.

4 Conclusion

This paper collects relevant literature data in the field of supplier selection and evaluation in 2001-2021, and it conducts a literature review using bibliometric analysis and inductive deduction, which is an innovation in review on supplier selection and evaluation. In terms of the key technologies, they can be divided into: model-driven approach, knowledge-driven approach, probabilistic statistics-driven approach, and data-driven approach. From the hotspot migration, the development of supplier selection and evaluation has gone through three main phases: the exploration period (2001-2006), the active period (2007-2012), and the blowout period (2013-present).

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