

Reviewing the Different Approaches to the Sourcing Decision Problem Domain

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The field of sourcing decision problems encompasses an extensive and continually expanding body of research literature, reflecting the complexity and significance of the decisions involved. Therefore, this paper does not strive for exhaustive coverage. Instead, its primary purpose is to illustrate the diversity of approaches and methods employed in addressing sourcing decision problems. The analysis of the literature indicates that consensus has been reached regarding the significance of the sourcing decision. However, various research studies highlight different aspects of the sourcing decision problem domain and employ a diverse array of methods and techniques. By highlighting different perspectives, methodologies, and research findings, this paper contributes to a deeper understanding of the complexities of sourcing decisions and provides valuable insights for practitioners and researchers alike.

When commerce began, buying was an ad hoc, unstructured and undefined activity. If we consider barter-type trades, where goods/services are exchanged directly without the use of currency, this practice can be traced back at least 100,000 years. Over time, purchasing emerged as a more structured process with defined and documented procedures and objectives. With the implementation of specific strategies, purchasing evolved into what is now known as procurement. Today, sourcing encompasses a broader role, shifting from the implementation of purchasing strategies to supporting the overall strategies of the organization.

The literature review strategy employed in this research is referred to as a 'bird's-eye view area mapping literature review' (Szendrey, 2016). This approach involved reviewing the sourcing decision literature to depict the richness of the field without aiming for

completeness. Through the analysis of the literature, several emergent themes were identified, which clustered around four main approaches to the sourcing decision problem, i.e. deciding whether to make or buy, selecting the appropriate supplier, vendor, service provider, or contractor, determining order quantity, scheduling, and price forecasting, and making outsourcing decisions.

Deciding Whether to Make or Buy

Some researchers are interested in make-or-buy decisions (Culliton, 1942; Venkatesan, 1992; Welch and Nayak, 1992; McIvor, Humphreys, et al., 1997; McIvor, Mulvenna, et al., 1997; Cánez et al., 2000; Humphreys et al., 2002; Platts et al., 2002; Hwang et al., 2007). Cánez et al. (2000) and Platts et al. (2002) propose a framework for addressing the make-or-buy decision for either a specific individual part or a family of parts. They emphasize the necessity of considering a wide range of factors beyond cost. Their framework categorizes the relevant factors of the make-or-buy decision into four areas: (a) technology and manufacturing processes, (b) cost, (c) supply chain management and logistics, and (d) support systems. Similarly, Hwang et al. (2007) focus on the make-or-buy decision model for manufacturing and procurement issues. They identify six primary factors for make-or-buy decision problems based on the literature: cost, quality, delivery speed, delivery reliability, volume flexibility and product flexibility.

Furthermore, Venkatesan (1992), Welch and Nayak (1992), McIvor, Humphreys, et al. (1997), and Humphreys et al. (2002) emphasize the importance of formulating make-or-buy decisions from a strategic perspective with senior management involvement, as these decisions have implications for the overall strategy of the company. For instance, in addition to static costs, Welch and Nayak (1992) outline strategic considerations regarding the make-or-buy decision, which include: (a) the role of process technology in providing competitive advantage, (b) the maturity of the process technologies under consideration, and (c) competitors' process technology positions. Finally, McIvor, Mulvenna, et al. (1997) present a more formalized approach to the make-or-buy decision. They developed a knowledge-based system to support strategic purchasing through the integration of Case-Based Reasoning and Multi-Attribute Analysis (MAA) approaches. Their make-or-buy model consists of five stages: (1) identification and weighting of

performance categories, (2) analysis of technical capability categories, (3) comparison of retrieved internal and external technical capability profiles, (4) analysis of suppliers' organization categories, and (5) total acquisition cost analysis.

Selecting the Appropriate Supplier, Vendor, Service Provider, or Contractor

Researchers show varying interests in procurement practices: while some explore purchasing in a broader context (Cook, 1997), others focus on specific aspects of the sourcing decision. A significant portion of the research conducted on sourcing decision modeling pertains to the selection of the appropriate supplier, vendor, service provider, or contractor (Lamberson and Diedrich, 1976; Cooper, 1977; Roberts, 1978; Narasimhan, 1983; Timmerman, 1986; Soukup, 1987; Monczka and Trecha, 1988; Nydick and Hill, 1992; Ng and Skitmore, 1995; Vokurka et al., 1996; Barbarosoglu and Yazgac, 1997; Boer et al., 1998; Weber et al., 1998; Degraeve et al., 2000; Liu et al., 2000; Handfield et al., 2002; Sarkis and Talluri, 2002; Kumar et al., 2004; Almeida, 2007; Cao and Wang, 2007; Jharkharia and Shankar, 2007; Mojsilovic et al., 2007; Sucky, 2007; Wadhwa and Ravindran, 2007). Lamberson and Diedrich (1976) propose a vendor rating system that assigns a score to a particular vendor as a potential manufacturer of a specific part. Their rating system consists of three phases: (1) characteristic rating – determining the value of certain vendor attributes, (2) vendor survey – measuring the degree to which a vendor possesses each attribute, and (3) part criticality – determining the criticality rating for the particular part. The vendor score, derived from the characteristic rating and vendor survey, combined with the part criticality rating, determines the value of a vendor for the particular part. Similarly, Roberts (1978) describes a vendor delivery rating model that expresses the cause and effect relationship between order quantity, delivery time, and production efficiency, as well as how this rating can serve as a decision-making tool. Meanwhile, Monczka and Trecha (1988) present a total cost-based supplier performance evaluation system for assessing key supplier performance factors.

Moreover, Ng and Skitmore (1995) introduce a prototype decision support system for contractor prequalification. Their system consists of three phases: (1) evaluating the capabilities of contractors based on project-specific criteria, (2) identifying risks that could be caused by contractors, and (3) evaluating contractors based on their likely

performance, management capability, reputation, resources, progress, competitiveness, and activeness. Additionally, Wadhwa and Ravindran (2007) propose a model for the vendor selection problem with multiple buyers and multiple vendors under price discounts. They approach the problem as a multi-objective optimization problem, considering three conflicting criteria (price, lead-time, and quality rejects) to be minimized simultaneously. They developed several models using weighted objective, goal programming, and compromise programming methods and compared the results of these models using the value path approach. Meanwhile, Almeida (2007) discusses a multi-criteria decision model for outsourcing contract selection. The evaluation of each contract is based on cost, quality, probabilistic delivery time, and confidence in quality commitment. The model integrates multi-attribute utility function and ELECTRE approaches, depending on whether compensation among the criteria is required or not.

Furthermore, Mojsilovic et al. (2007) propose a logistic regression framework applicable across the outsourcing lifecycle. This framework is designed to select new vendors, manage the existing client portfolio, and quantify the realized benefits to the client resulting from the outsourcing agreement. In contrast, some researchers focus on specific aspects of vendor selection, such as dynamic strategic aspects (Sucky, 2007), environmental aspects (Handfield et al., 2002), and total cost of ownership (Degraeve et al., 2000). Finally, Boer et al. (2001), Holt (1998), and Weber et al. (1991) provide a comprehensive review of the methods used to support the supplier selection process.

Determining Order Quantity, Scheduling, and Price Forecasting

Expanding their research scope, some scholars go beyond supplier selection to address other issues, including order quantity (Benton, 1983; Banerjee, 1986a, 1986b; Kasilingam and Lee, 1996; Ghodsypour and O'Brien, 1998; Vaidyanathan et al., 1999; S. Yang et al., 2007; Özgen et al., 2008), order scheduling (Anthony and Buffa, 1977; Buffa and Jackson, 1983; Ronen and Trietsch, 1988), and price forecasting (Kingsman, 1986). Benton (1983) compares three purchase quantity discount procedures in various material requirements planning-based operating environments. They conducted simulation experiments with time-phased demand, economic order quantity, and McLaren's Order Moment procedures. Their results indicate that purchase quantity lot

sizing procedures considering time-phased demand outperform traditional economic order quantity-based purchase quantity discount procedures. Meanwhile, the McLaren's Order Moment procedure exhibits the best cost performance. Moreover, Banerjee (1986a) describes a joint economic-lot-size model for purchasers and vendors, where a vendor produces the order for a purchaser on a lot-for-lot basis assuming deterministic demand and lead times. The model, based on the joint total relevant cost, demonstrates that a jointly optimal ordering policy coupled with an appropriate price adjustment can be economically beneficial for both parties.

Furthermore, Kasilingam and Lee (1996) present a mixed-integer programming model to select vendors and determine order quantities. The model considers factors such as the (a) cost of purchasing and transportation, (b) fixed costs for establishing vendors, (c) costs of receiving poor-quality parts, (d) stochastic nature of demand, (e) quality of supplied parts, and (f) lead time requirements for the parts. Similarly, Ghodspour and O'Brien (1998) discuss the integration of an analytical hierarchy process and linear programming for selecting the best suppliers and placing optimum order quantities among them. The analytical hierarchy process enables the consideration of both quantitative and qualitative decision factors when calculating ratings for suppliers. These ratings are then used as coefficients of an objective function in linear programming to allocate optimum order quantities among the chosen suppliers to maximize the total value of purchasing. Özgen et al. (2008) integrate analytic hierarchy process and multi-objective possibilistic linear programming to evaluate and select suppliers and define optimum order quantities assigned to them. Additionally, S. Yang et al. (2007) propose a decision model for ordering quantities from a set of suppliers with different yield rates and unit costs while facing random demand.

Focusing now more specifically on order scheduling, Buffa and Jackson (1983) propose a goal programming model to schedule purchases from a mix of vendors over a defined planning period. The model combines the buyer's operating characteristics (e.g. safety stock levels, material requirements) with the vendor attributes (e.g. product quality, price, service experience, timeliness of shipments). Meanwhile, Anthony and Buffa (1977) present a strategic purchase scheduling model to minimize the total long-range inventory costs during periods of rising prices. Additionally, Ronen and Trietsch (1988) introduce a model-based decision support system for supplier selection and order

scheduling of components and materials for large projects. They suggest two scenarios for how the system can be used: (a) executing a project – managing purchasing to minimize the expected costs (deciding from whom and when to order each item), and (b) bidding for a project – assessing the costs related to the purchasing decision before bidding. Finally, Aissaoui et al. (2007) provide a review of supplier selection and order lot sizing modeling.

Making Outsourcing Decisions

A significant portion of the related business literature delves into outsourcing decisions (Araz et al., 2007; Isiklar et al., 2007; Olson, 2007; Tsai and Lai, 2007; J.-J. Wang and Yang, 2007; D.-H. Yang et al., 2007). Araz et al. (2007) propose an evaluation and management system for outsourcers in a textile company, aiming to evaluate, manage, and select suppliers. Initially, the company's existing outsourcers are evaluated based on decision makers' criteria using PROMETHEE. Then, potential strategic partners are identified, and quantities to be ordered from them are allocated using fuzzy goal programming. Similarly, J.-J. Wang and Yang (2007) outline a hybrid multi-criteria decision model for information systems outsourcing. They apply the analytic hierarchy process to analyze the outsourcing problem and determine the weights of the criteria, followed by PROMETHEE for final ranking and sensitivity analysis. Six decision factors are recognized:

- Economics – Outsourcing can lead to cost reduction and enhanced financial flexibility.
- Resource – Outsourcing can enable companies to access new technologies and skilled labor.
- Strategy – Outsourcing enables companies to focus on their core activities.
- Risk – Outsourcing can introduce additional risks, including the loss of core competences, internal technical knowledge, and flexibility, which can undermine the company's innovative capability and increase the complexity of information services management.
- Management – Outsourcing necessitates increased attention to communication issues, ethical considerations, and other managerial challenges.

- Quality – Outsourcing can result in companies acquiring services of improved quality.

Finally, Isiklar et al. (2007) introduce a hybrid intelligent decision support framework for evaluating and selecting logistics outsourcing partners effectively. The proposed framework integrates rule-based reasoning, case-based reasoning, and compromise programming techniques. They emphasize that logistics outsourcing in a ‘fuzzy environment’ entails uncertain and imprecise decision-making. Therefore, they categorize the evaluation criteria into two groups: (a) strategic aspects – e.g. financial stability, successful track record, similar size, comparable culture, shared values and goals, and suitability for fostering a sustainable relationship, and (b) key aspects of the supplier’s business – e.g. information technology, performance, quality, cost, and services.

It is important to distinguish between offshore outsourcing and offshoring. For example, Pai and Basu (2007) define offshore outsourcing as the sourcing of a business process from an external supplier located in a different country from the outsourcing company’s location. In contrast, offshoring means that some of the business processes of the parent company are carried out in its overseas subsidiary. Consequently, certain researchers, when considering the factors influencing outsourcing decisions, focus specifically on aspects related to offshoring, such as legal implications (Hartman et al., 2007; Pai and Basu, 2007) and risks (Colwill and Grey, 2007; Welborn, 2007). Hartman et al. (2007) examined the impact of US tax depreciation laws on asset location and ownership decisions. They found that because depreciation rules vary based on the location of assets of US corporations, directly owned foreign assets may seem less appealing. In a broader context, understanding international tax law proves more important than differences in tax rates among countries. Meanwhile, Colwill and Grey (2007) introduced a risk model and supporting process to identify the key risk factors of offshoring ICT to India from the UK. These risk factors include specific environmental conditions, the number of third-party personnel involved in the contract, and the level of trust placed in these personnel.

One of the primary risks associated with outsourcing is the potential loss of core competences. Consequently, some researchers, when considering the factors influencing outsourcing decisions, focus on issues related to the loss of core competences (McIvor, Humphreys, et al., 1997; McIvor, 2005; Hafeez et al., 2007). McIvor (2005) presents a

framework for evaluating and managing outsourcing, developed based on the literature and empirical evidence. His framework consists of six stages:

- Determining the current boundary of the organization – The purpose of this stage is to identify the scope of activities performed by the organization to create a range of products and services for customers.
- Analyzing the importance of organizational activities – The purpose of this stage is to identify the level of importance of the activities identified in the previous stage, as critical activities significantly impact the organization's ability to achieve a competitive advantage.
- Assessing relative capabilities – The purpose of this stage is to compare the organization's capabilities in the identified activities with those of potential external sources.
- Evaluating strategic sourcing options – The purpose of this stage is to evaluate the implications of strategic sourcing options by comparing the importance level and capabilities of scrutinized activities with those of external resources.
- Relationship strategy – The purpose of this stage is to emphasize the importance of developing collaborative relationships with suppliers to mitigate risks associated with external sourcing.
- Establishing, managing, and evaluating appropriate relationships with external sources.

Meanwhile, Hafeez et al. (2007) describe a structured framework for evaluating a company's assets and competencies using a two stage analytic hierarchy process. To identify the core competence of a company, they recognize a set of six attributes related to uniqueness (i.e. rareness, inimitability, and non-substitutability) and collectiveness (i.e. across-function, across-product and across-business).

Additionally, outsourcing can increase the complexity of supply chain networks. Therefore, some researchers investigate the sourcing decision from a broader supply chain perspective (Vaidyanathan et al., 1999; Liu et al., 2000; Sarkis and Talluri, 2002; Yan et al., 2003; Kumar et al., 2004; G. Wang et al., 2004). Kumar et al. (2004) formulate the vendor selection problem in a supply chain as a fuzzy mixed integer goal programming problem, considering three primary goals: (a) minimizing net cost, (b) minimizing net

rejections, and (c) minimizing net late deliveries. They also account for practical constraints such as buyer demand, vendor capacity limitations, vendor quota flexibility, and budget allocations to individual vendors. Similarly, Vaidyanathan et al. (1999) propose a mixed integer programming model to select an optimal set of suppliers and make allocations based on demand quality requirements, storage and production capacity constraints, production lead-time, and lead-time requirements. Finally, G. Wang et al. (2004) describe a product-driven supply chain selection model using integrated analytic hierarchy process and pre-emptive goal programming. They highlight the importance of focusing on the manufactured product when making decisions about supply chain design, particularly considering product characteristics and the product life cycle.

IN CONCLUSION, the findings of the bird's-eye view area mapping literature review on sourcing decision problems indicate that consensus has been reached regarding their significance. However, various research studies highlight different aspects of this domain and employ a diverse array of methods and techniques. Through literature analysis, several emergent themes were identified, which clustered around four main approaches: deciding whether to make or buy, selecting the appropriate supplier, vendor, service provider, or contractor, determining order quantity, scheduling, and price forecasting, and making outsourcing decisions. Outsourcing introduces additional decision factors, such as the loss of core competences, increased complexity of supply chain networks, and the legal implications and risks associated with offshoring. Researchers in these studies have employed a diverse range of methods and techniques, including mathematical programming models, statistical/probabilistic approaches, multi-criteria decision analysis, and expert systems. This diversity in approaches and methods reflects the complexity and significance of sourcing decisions.

Summary of the Literature: Different Approaches to the Sourcing Decision Problem

Reference	Abstract	Sourcing approach	Support/model
Aissaoui et al., 2007	With globalization and the emergence of the extended enterprise of interdependent organizations, there has been a steady increase in the outsourcing of parts and services. This has led firms to give more importance to the purchasing function and its associated decisions. One of those decisions which impacts all firms' areas is the supplier selection. Since the 1950s, several works have addressed this decision by treating different aspects and instances. In this paper, we extend previous survey papers by presenting a literature review that covers the entire purchasing process, considers both parts and services outsourcing activities, and covers internet-based procurement environments such as electronic marketplaces auctions. In view of its complexity, we will focus especially on the final selection stage that consists of determining the best mixture of vendors and allocating orders among them so as to satisfy different purchasing requirements. In addition, we will concentrate mainly on works that employ operations research and computational models. Thereby, we will analyze and expose the main decision's features, and propose different classifications of the published models.	supplier selection + order quantity (literature review)	
Almeida, 2007	An outsourcing contract problem has been analyzed. This is a typical problem when dealing with outsourcing vendor selection. For each alternative of an outsourcing contract there is an evaluation of both cost and quality of service. The latter may include probabilistic delivery time and confidence in quality commitment. The decision-maker takes into account multicriteria evaluation through ELECTRE method. Besides, each criterion is evaluated through a utility function. The model integrates both approaches to indicate a contract proposal. This paper presents the formulation for the decision model and a numerical application to illustrate the use of the model.	contract selection	MAUT + ELECTRE
T. F. Anthony and Buffa, 1977	During periods of rising prices, strategic purchase scheduling (SPS) can significantly affect the cost of maintaining crucial inventories. Strategic purchase scheduling refers to the development of a purchasing schedule designed to reduce the total long-range inventory costs to minimum levels by taking maximum advantage of the price/storage trade-off. In addition to material needs for projected production levels, information regarding projected price variations is incorporated into the development of the purchasing strategy. In contrast to 'purchase as needed' and 'fixed flow' purchasing plans, SPS involves variable material flows that may not coincide with production schedules. If care is taken, the purchasing system can be reasonably described and modelled. Furthermore, the model can be effective and valuable by indicating areas in which cost reductions might be sought and by providing bench-mark figures indicating additional potential savings.	order scheduling	linear programming

Reference	Abstract	Sourcing approach	Support/model
Araz et al., 2007	In this study, an outsourcer evaluation and management system is developed for a textile company by use of fuzzy goal programming (FGP). At first phase of the methodology, evaluation criteria for the outsourcers and the objectives of the company are determined. The existing outsourcers of the company are evaluated by PROMETHEE. At the second phase, the FGP model developed selects the most appropriate outsourcers suitable to be strategic partners with the company and simultaneously allocates the quantities to be ordered to them. In the end, the results achieved are compared with the current situation of the company. The results indicated that scientific methodology for outsourcer management system is very beneficial for the company.	outsourcing (evaluation and management system)	PROMETHEE + FGP
Banerjee (1986a)	In a usual purchasing situation, such issues as price and lot sizing generally are settled through negotiations between the purchaser and the vendor. Depending on the existing balance of power, the end result of such a bargaining process may be a near-optimal or optimal ordering policy for one of the parties or, at times, in optimal policies for both parties. A joint economic-lot-size model for a special case in which a vendor produces to order for a purchaser on a lot-for-lot basis under deterministic conditions is presented. The crux of the model is the joint total relevant cost. It is demonstrated that a jointly optimal ordering policy, together with an appropriate price adjustment, can be beneficial economically for both parties or, at the least, does not place either at a disadvantage. The primary limitation of this approach is the assumption of deterministic demand and lead times.	order quantity (deterministic demand and lead times)	joint economic-lot-size model (purchaser and vendor)
Banerjee (1986b)	Monahan (1984) develops a model for establishing an optimal quantity discount schedule from a vendor's viewpoint. In this note we show that this model is limited to the case where the vendor buys from another supplier. Incorporating vendor's inventory carrying costs, we develop a generalized version of Monahan's model and demonstrate its equivalence with the joint economic lot size approach suggested by Banerjee (1986).	order quantity (optimal quantity discount pricing)	joint economic-lot-size model
Barbarosoglu and Yazgac, 1997	A study designs an analytic hierarchy process (AHP) model to solve the supplier selection problem in Turkish industry. A general purpose model is then applied to the leading electro motor manufacturer of Turkey, Turk Elektrik Endustrisi Inc. TOPEM Plant, which is also a supplier for a well-known household appliances manufacturer.	supplier selection	AHP

Reference	Abstract	Sourcing approach	Support/model
Benton, 1983	The concept of material requirements planning (MRP) allows the operating manager to plan material requirements to meet the final assembly schedule, thus improving the inventory results of a traditional non-time-phased order point system. A simulation experiment compared 3 purchase quantity discount procedures in a number of MRP based operating environments. Results indicate that purchase quantity lot sizing procedures which consider time-phased demand outperform the traditional economic order quantity (EOQ) based purchase quantity discount procedure. The McLaren's Order Moment (MOM) procedure showed the best overall cost performance. Although the selection of the purchase quantity procedure appears to be less important when the discount is attractive, differences between the results of the procedures increase as the acquisition cost increases and as the discount quantity relative to the EOQ increases.	order quantity discount	simulation
Boer et al., 1998	Initial purchasing decisions such as make-or-buy decisions and supplier selection are decisions of strategic importance to companies. The nature of these decisions usually is complex and unstructured. Management Science techniques might be helpful tools for this kind of decision making problems. So far, however, the application of outranking methods in purchasing decisions has not been suggested in purchasing or operations research literature. In this paper we show by means of a supplier selection example, that an outranking approach may be very well suited as a decision-making tool for initial purchasing decisions.	supplier selection	outranking methods
Boer et al. (2001)	In this paper we present a review of decision methods reported in the literature for supporting the supplier selection process. The review is based on an extensive search in the academic literature. We position the contributions in a framework that takes the diversity of procurement situations in terms of complexity and importance into account and covers all phases in the supplier selection process from initial problem definition, over the formulation of criteria, the qualification of potential suppliers, to the final choice among the qualified suppliers. Moreover, we propose decision methods and techniques that previously have not been suggested in a purchasing context. The proposed methods specifically accommodate for buying situations for which few or no decision models were published so far. This paper extends previous reviews by Weber et al. (Eur. J. Oper. Res. 50 (1991) 2), Holt (Int. J. Project Manage. 16 (1998) 153) and Degraeve et al. (Eur. J. Oper. Res. 125 (1) (2000a) 34) in that it classifies the models in a framework developed by De Boer (Ph. D. Thesis, University of Twente, Enschede, The Netherlands, 1998) which recognises more steps in the buying process than only the final among qualified suppliers and accommodates for the diversity of procurement situations.	supplier selection	literature review

Reference	Abstract	Sourcing approach	Support/model
Buffa and Jackson, 1983	Purchasing decisions have an effect on production scheduling, inventory cost/management, and cash flow of the enterprise. A model has been developed to schedule purchases from a mix of vendors over a defined planning period. The model combines vendor attributes, such as product quality, price, service experience, and timeliness of shipments with such operating characteristics of the buying firm as safety stock levels and material requirements. It extends the research on vendor rating to include the effects on the operations of the company. The model leaves the purchasing manager in a position to improve relations with successful vendors who can be given notice for orders in advance. The purchasing manager can negotiate service levels and other purchase conditions, and by modifying inputs, he can evaluate the impact of changing business conditions on purchasing plans.	order scheduling (mix of vendors over a defined planning period)	goal programming
Cáñez et al., 2000	The make-or-buy question represents a fundamental dilemma faced by many companies. Companies have finite resources and cannot always afford to have all manufacturing technologies in-house. This has resulted in an increasing awareness of the importance of make-or-buy decisions. This paper reports on the development of a make-or-buy framework to address the make-or-buy for either a specific individual part or family of parts. firstly, a literature review of the principal make-or-buy approaches is discussed. Secondly, the development of a make-or-buy framework is described and the framework is explained and illustrated using case studies. Thirdly, the operationalisation of the framework is outlined. the paper concludes with a discussion of its contribution to both the academic understanding of the subject, and the improvement of industrial practice.	make-or-buy	framework
Cao and Wang, 2007	The decision processes surrounding outsourcing are complicated by the very nature of uncertainty involved in the outsourcing process and by poor vendor management. In this study, we focus on vendor selection, one of the two basic issues of vendor management in outsourcing. Due to the limitation of the classic one-stage vendor selection model, we propose a two-stage vendor selection research framework in outsourcing. The first stage is a trial phase that helps the client to find the best match between the vendor and the outsourced project. In the second stage, the client employs the chosen vendor for the full implementation of the project. We formulate this selection decision under the two-stage framework as a combinatorial optimization model. We analyze the complexity of the problem and develop a solution procedure to find the exact optimal solution. By applying this model to numerical case studies, we demonstrate that benefit to adopt two-stage process to the vendor depends on information improvement in the first stage and the client's ability to adapt to updated knowledge. We also argue that the selection of vendors for the first stage testing is more about creating a good vendor portfolio than simply picking the frontrunners.	vendor selection	combinatorial optimization

Reference	Abstract	Sourcing approach	Support/model
Colwill and Grey, 2007	Globalisation has had a fundamental impact on the way that business is conducted and approaches to sourcing work have evolved. Outsourcing is here to stay and the proportion of worldwide spend in this market-place will continue to rise. BT's security community has successfully introduced a new risk model and supporting process to identify the key risk factors applicable to outsourcing, namely, specific environmental conditions, the number of third party personnel involved in the contract and the level of 'trust' given to these personnel. The importance of protective monitoring and audit regimes is highlighted from both a compliance and assurance perspective - and is being used to create effective engagement with outsourcing partners to raise security thresholds and discuss security issues. Globalisation, coupled with the requirement for more open networks, will continue to increase in the future and result in corporate infrastructure fragmentation and the breaking down of traditional boundaries. At the same time, approaches to security must also evolve - moving the focus from the infrastructure to the client, application and eventually the data level.	outsourcing (offshoring)	risk model
R. L. Cook, 1997	Case-based reasoning systems are artificial intelligence software programs that show significant promise for improving the effectiveness and efficiency of purchasing management decision making. Case-based reasoning systems are described, several purchasing case-based system applications that offer significant potential for future developments are presented and guidelines are offered for case-based reasoning system development.	purchasing	CBR
Cooper, 1977	The most common measure of delivery performance is in terms of the percentage of orders delinquent, but the important question is - when is an order delinquent. Clearly, a one piece delinquency on an original order of 1000 pieces is not nearly as disruptive as an order for 1000 pieces, all of which are completely delinquent. However, the usual measurement of performance would suggest that the delinquencies of both orders carry equal weight. To assess delivery performance better, factors must be considered - 1. All purchase orders placed, whether completed or not, should be included in the computation. 2. The number of devices delinquent on each order should be the significant part of a supplier's performance rating. 3. The delinquency must be stated in terms of time.	supplier selection (delinquency issues)	total system for measuring delivery performance

Reference	Abstract	Sourcing approach	Support/model
Culliton, 1943	"This study offers an excellent analysis of the business problem faced by manufacturing concerns when deciding whether to make or to buy the industrial goods needed. The analysis deals with all industrial goods except installations and primary materials but is confined to manufacturing organizations. Two significant accomplishments of the study are that (1) it directs attention to the importance of the make-or-buy problem and that (2) it develops a set of principles to evaluate make-or-buy decisions. These principles are developed through the use of numerous cases, twelve of which are compiled by the author."	make-or-buy	
Degraeve et al., 2000	Many different vendor selection models have been published in the purchasing literature. However there has been no systematic approach to compare the relative efficiency of the systems. In this paper we propose to use the concept of Total Cost of Ownership as a basis for comparing vendor selection models. We illustrate the comparison with a real life data set of the purchasing problem of ball bearings at Cockerill Sambre, a Belgian multinational company in the steel industry. From a Total Cost of Ownership perspective mathematical programming models outperform rating models and multiple item models generate better results than single item models for this specific case study.	vendor selection	evaluation of vendor selection models based on TCO
Ghodsypour and O'Brien, 1998	Supplier selection is a multicriteria problem which includes both qualitative and quantitative factors. In order to select the best suppliers it is necessary to make a trade off between these tangible and intangible factors some of which may conflict. When capacity constraints exist, this problem becomes more complicated as, in these circumstances, managers should decide about two problems: which suppliers are the best and how much should be purchased from each selected supplier. Some authors have applied mixed integer, goal and multi-objective programming to solve this problem. As these techniques are mathematical, they have significant problems in considering qualitative factors which are very important in supplier selection, especially when supplier partnership is desired. In this article an integration of a analytical hierarchy process and linear programming is proposed to consider both tangible and intangible factors in choosing the best suppliers and placing the optimum order quantities among them such that the total value of purchasing (TVP) becomes maximum. This model can be applied to supplier selection with and without capacity constraints. A numerical example is presented and the model advantages are discussed.	supplier selection + order quantity	AHP + LP

Reference	Abstract	Sourcing approach	Support/model
Hafeez et al., 2007	This paper provides a structured framework for evaluating the firm assets and competences using a two stage analytic hierarchy process (AHP). One distinctive characteristic of this framework is that relationship between firm competence and intellectual assets is established and a set of six attributes related to uniqueness and collectiveness are identified to help identify the core competence of a company. Using a balance score card type financial and non-financial procedure, these attributes are subsequently employed for isolating the competence and tangible and intangible assets of a UK manufacturing company. Our analysis illustrates that the intellectual assets such as marketing knowledge, design skills, manufacturing skills and customer relationship those usually ignored within the balance sheet of a company have been perceived relatively important than the tangible assets such as space and equipment. We argue that results based on AHP-based quantitative analysis would help a company to make more informed strategic management decision concerning further investment for competences and key assets development, and outsourcing non-core assets and competences.	outsourcing (core competences)	AHP
Handfield et al., 2002	Increasingly, purchasing managers are being asked not only to transform purchasing into a more strategic function but also to integrate environmental issues in their decisions. Introducing the environmental dimension into purchasing decisions embeds a new set of trade-offs in the decision, complicating the decision-making process with both qualitative and quantitative factors. Yet, few companies use any structured analysis to evaluate suppliers along environmental dimensions. In this study, we illustrate the use of the Analytical Hierarchy Process (AHP) as a decision support model to help managers understand the trade-offs between environmental dimensions. We then demonstrate how AHP can be used to evaluate the relative importance of various environmental traits and to assess the relative performance of several suppliers along these traits. Three case studies were carried out to demonstrate the benefits and weaknesses of using AHP in this manner. Finally, we examine how AHP can be incorporated into a comprehensive information system supporting Environmentally Conscious Purchasing (ECP).	supplier assessment (environmental issues)	AHP

Reference	Abstract	Sourcing approach	Support/model
Hartman et al., 2007	The decision of whether to manufacture products within the US, manufacture internationally or to outsource production depends critically upon a thorough understanding of the costs and benefits of each option. In this paper, we contribute to such an understanding by considering the impact of US tax depreciation rules, which differ depending upon whether a US corporation locates its assets at domestic or foreign branches. Our analysis and illustrative examples demonstrate that US depreciation law can indeed have a non-trivial impact on location and sourcing decisions, with direct ownership of foreign assets appearing relatively less attractive once depreciation law is taken into account. More broadly, our results demonstrate that comprehensive asset location and ownership decisions require a detailed understanding of international tax law, rather than just a simple recognition of differences in tax rates among countries.	outsourcing (offshoring)	impact of tax depreciation law
Holt, 1998	Industrial and academic awareness of the need for judicious construction contractor selection is increasing. Earlier investigations of this client procurement decision have more recently been expanded upon; particularly, by work conducted in the USA and UK. Other countries are now also addressing this issue and procurement research abounds. This paper complements that increased activity by presenting a review of contractor evaluation and selection modelling methodologies. These methodologies include: Bespoke approaches, Multi-attribute analysis, Multi-attribute utility theory. Cluster analysis, Multiple regression, Fuzzy set theory, and Multivariate discriminant analysis. The merits/ demerits and previous/possible future applications of each methodology are discussed, and indications for future research given.	contractor evaluation and selection	literature review
Humphreys et al., 2002	The aim of this paper is to show how knowledge-based systems technology can assist in the area of strategic purchasing. The authors discuss a knowledge-based system (KBS) designed to help companies in the make or buy decision, which is arguably the most fundamental component of manufacturing strategy. a model of the make or buy decision was developed conceptually from a thorough review of the literature and was supported by a series of interviews with procurement managers. The model consists of five main stages: identifying the weighting performance categories; analysing technical capabilities; comparing internal and external capabilities; analysing supplier organisational capabilities; total acquisition cost analysis. A KBS was developed which incorporates these five phases into the outsourcing decision. Preliminary evaluation indicates that the KBS can assist the purchasing team by providing feedback to suppliers, monitoring suppliers against performance benchmarks, improving cooperation between the multifunctional purchasing team members and reduces the time involved in conducting the make or buy evaluation. Ultimately, the KBS tool developed can assist an organisation in enhancing its competitive position.	make-or-buy	KBS-CBR

Reference	Abstract	Sourcing approach	Support/model
Hwang et al., 2007	This paper is concerned with the make-or-buy decision model for manufacturing and procurement problems. We developed a web-based two-step approach as follows: (1) for the first step, we used the multi-attribute analysis method using the AHP (analytic hierarchy process); and (2) for the second step we, used fuzzy set ranking methodologies to integrate the special decision problems that are problems involving multi-objectives, multi-criteria, and multi-attributes. We propose a procedure for integrating the comparative judgments and priorities for make-or-buy decisions and for the optimal resource allocation. First, we determine the rank-ordered priority lists of the projects based on the AHP, and then we compute the aggregate fuzzy set rank order. Finally, we develop a systematic and practical program for a simple and easy calculation of all the algorithms used in this study. It is found that the proposed model can be validated by comparative computations in various make-or-buy example problems for a cellular manufacturing system.	make-or-buy	Fuzzy-AHP
Isiklar et al., 2007	Outsourcing is an increasingly important issue pursued by corporations seeking improved efficiency. Logistics outsourcing or third-party logistics (3PL) involves the use of external companies to perform some or all of the firm's logistics activities. This paper proposes an intelligent decision support framework for effective 3PL evaluation and selection. The proposed framework integrates case-based reasoning, rule-based reasoning and compromise programming techniques in fuzzy environment. This real-time decision-making approach deals with uncertain and imprecise decision situations. Furthermore, the integration of different methodologies takes the advantage of their strengths and complements each other's weaknesses. Consequently, the framework leads to a more accurate, flexible and efficient retrieval of 3PL service providers (alternatives) that are most similar and most useful to the current decision situation. Finally, a real industrial application is given to demonstrate the potential of the proposed framework.	outsourcing	CBR + RBR +CP
Jha'kharria and Shankar, 2007	This article presents a comprehensive methodology for the selection of a logistic service provider. The proposed methodology consists of two parts: (i) preliminary screening of the available providers, and (ii) analytic network process (ANP)-based final selection. The criteria, which are relevant in the selection of a provider, have been identified and used to construct an ANP model. Thereafter, the application of ANP for the final selection of a provider has been demonstrated through an illustrative example. The results of this example indicate that compatibility between the user and the provider companies is the most important determinant, which influences the final selection process. This approach also enables the decision-makers to better understand the complex relationships of the relevant attributes in the decision-making, which may subsequently improve the reliability of the decision.	service provider selection	ANP

Reference	Abstract	Sourcing approach	Support/model
Kasilingam and Lee, 1996	In this paper, we propose a mixed-integer programming model to select vendors and determine the order quantities. The model considers the stochastic nature of demand, the quality of supplied parts, the cost of purchasing and transportation, the fixed cost for establishing vendors, and the cost of receiving poor quality parts. The model also considers the lead time requirements for the parts.	vendor selection + order quantity	mixed-integer programming
Kingsman, 1986	One major area of a company's operations that has received little attention from OR practitioners is that of purchasing, particularly the problem of buying materials whose prices are continually fluctuating in a stochastic-uncertain manner over time. A common misconception is that purchasing is merely a minor aspect of classical inventory control. The aim of this review is to highlight the real problems that exist. The component stages of the commodity purchasing decision and hence the different approaches and skills required are identified. Various methods and models that have been proposed and applied to the different stages are described. Important aspects are the inadequacy of classical inventory models, the application of linear programming to the blending problem, price forecasting via econometric and time series analysis and sequential decision making for day to day buying.	price forecasting (commodity)	linear programming
Kumar et al., 2004	A fuzzy goal programming approach is applied in this paper for solving the vendor selection problem with multiple objectives, in which some of the parameters are fuzzy in nature. A vendor selection problem has been formulated as a fuzzy mixed integer goal programming vendor selection problem that includes three primary goals: minimizing the net cost, minimizing the net rejections, and minimizing the net late deliveries subject to realistic constraints regarding buyer's demand, vendors capacity, vendors' quota flexibility, purchase value of items, budget allocation to individual vendor, etc. An illustration with a data set from a realistic situation is included to demonstrate the effectiveness of the proposed model. The proposed approach has the capability to handle realistic situations in a fuzzy environment and provides a better decision tool for the vendor selection decision in a supply chain.	vendor selection (supply chain)	fuzzy mixed integer goal programming
Lamberson and Diedrich, 1976	A vendor rating system is suggested that will provide a numerical rating for a particular vendor as a potential source for a particular part. Its objectives are to remove bias from the vendor selection, make vendor evaluation systems self-correcting, make source selection systems adaptable to new and established sources, and quantify all important source characteristics, among others. The rating system consists basically of three phases, a characteristic rating, a vendor survey, and part criticality. The characteristic rating determines the utility or value of certain vendor attributes, the vendor survey measures the degree to which a vendor possesses each attribute, and the characteristics rating and vendor survey are then used to establish a particular vendor score. This score, when combined with the criticality rating, results in the value of a vendor for manufacturing the particular part.	vendor evaluation	linear weighting

Reference	Abstract	Sourcing approach	Support/model
Liu et al., 2000	A simplified data envelopment analysis model for supplier selection is first presented to evaluate the overall performances of suppliers with a strategic orientation of being able to reduce the number of suppliers. A case study is presented to demonstrate supplier performance evaluation using data envelopment analysis for supplier selection and performance improvement considerations.	supplier selection (supply chain)	DEA
McIvor, 2005	Outsourcing has become an increasingly important issue for many organisations. This book provides a framework for an up-to-date understanding of the outsourcing process and the key issues associated with it. It integrates a number of contemporary topics including benchmarking, buyer–supplier relationships, organisational behaviour, competitor analysis, and technology influences. The analysis draws upon both empirical research and real case studies. The author starts by providing guidelines as to when outsourcing is appropriate and what its implications will be, before moving on to explain how outsourcing is implemented. The benefits of both successful outsourcing and the risks and consequences of outsourcing failure are outlined. The book is ideal for use by postgraduate students studying the area of outsourcing. It would also benefit industry managers who are considering outsourcing or who already have outsourcing programmes in place.	outsourcing (core competences)	framework
McIvor, Humphreys, et al., 1997	The aim of this paper is to illustrate that the make or buy is a strategic decision and has implications for the overall corporate strategy of the organization by describing a model which involves analysing a number of strategic factors. In recent years, many companies have been moving significantly away from “making” towards “buying”. However, research has revealed that make or buy decisions are rarely taken within a thoroughly strategic perspective. It has been shown that many firms adopt a short-term perspective and are motivated primarily by the search for short-term cost reductions. It is argued that make or buy decisions are made most frequently by default with little consideration for the long-run competitiveness of the organization. Presents an outline of three key problems encountered by companies in their efforts to formulate an effective make or buy decision to illustrate the weaknesses in current make or buy practice. The make or buy model described in this article attempts to overcome these problems by offering an organization a conceptual framework to follow in the sourcing decision.	make-or-buy	impact of core competences

Reference	Abstract	Sourcing approach	Support/model
McIvor, Mulvenna, et al., 1997	The aim of this paper is to show how knowledge-based systems technology can assist in the area of strategic purchasing. The authors discuss a knowledge-based system (KBS) designed to help companies in the make or buy decision, which is arguably the most fundamental component of manufacturing strategy. As part of the development process, procurement managers in ten multi-national companies were interviewed to determine current make or buy practice and elicit opinions on how the decision-making process could be enhanced. The general consensus was that a formal structure was needed along with computerized support at various stages in the process. The model was developed conceptually from the analysis of these interviews with procurement managers and also through a thorough literature survey of the area. The next stage was to computerize the most important components of the system to enable feedback from procurement managers in two of the multi-nationals first interviewed. Within the description of this KBS there is specific focus on the issues involved in the application of case-based reasoning (CBR) techniques and Multi-Attribute Analysis (MAA) to the automation of the make or buy decision. The development of this system is intended to illustrate that a case-based system should be capable of providing sound solutions utilizing relatively small case libraries, while avoiding a large rule base and long rule chains necessary if rule-based reasoning was used exclusively.	make-or-buy	CBR+MAA
Mojilovic et al., 2007	We present a methodology for managing outsourcing projects from the vendor's perspective, designed to maximize the value to both the vendor and its clients. The methodology is applicable across the outsourcing lifecycle, providing the capability to select and target new clients, manage the existing client portfolio and quantify the realized benefits to the client resulting from the outsourcing agreement. Specifically, we develop a statistical analysis framework to model client behavior at each stage of the outsourcing lifecycle, including: (1) a predictive model and tool for white space client targeting and selection—opportunity identification (2) a model and tool for client risk assessment and project portfolio management—client tracking, and (3) a systematic analysis of outsourcing results, impact analysis, to gain insights into potential benefits of IT outsourcing as a part of a successful management strategy. Our analysis is formulated in a logistic regression framework, modified to allow for non-linear input-output relationships, auxiliary variables, and small sample sizes. We provide examples to illustrate how the methodology has been successfully implemented for targeting, tracking, and assessing outsourcing clients within IBM global services division.	managing vendors	logistic regression framework

Reference	Abstract	Sourcing approach	Support/model
Monczka and Trecha, 1988	Cost-based management of the supplier base becomes increasingly important as the array of business factors that affect a firm's ability to compete expands. The purchasing function, through its integral interface with the supplier base, can institute a performance measurement system that both quantifies suppliers' performance in terms of cost and enhances the buy-sell relationship. A cost-based supplier performance evaluation system provides a justifiable and rational method for evaluating key supplier performance factors. The system is predicated on the recognition that material price is only a fraction of the cost of the purchased material. It identifies supplier non-performance costs and accurately reflects the actual cost doing business with suppliers. In this article the authors discuss the development of a cost-based supplier performance evaluation system, based on their work with an electronics firm. The relevance of the system to purchasing and the buy-sell relationship is presented, and the system logic is details. Additionally, the implementation approach is overviewed and application conclusions are drawn.	supplier performance evaluation	cost-based model
Narasimhan, 1983	Supplier selection is one of the most important decisions a buyer makes. It is typical of managerial problems which involve trade-offs among multiple criteria that are largely qualitative. The analytic hierarchic process is a relatively new method that when applied to the supplier selection problem accomplishes the following: 1. It provides a systematic approach that focuses on commonly used evaluation criteria. 2. By using a step-by-step approach to quantification, the difficult task of processing information about vendors is simplified. 3. Although subjectivity is not removed, it is tempered by a more consistent application across alternatives. 4. Development of the criterion weights and rating and ranking of the vendors are accomplished in one integrated procedure. An overview of the analytic hierarchic process and an illustrative example are given. As a by-product of the method, management gets to know the implicit weights that are being placed on the evaluation criteria.	supplier selection	AHP
Ng and Skitmore, 1995	A prototype decision support/expert system for contractor prequalification, CP-DSS, is described. The system firstly evaluates contractors' capabilities according to project specific criteria. It then identifies any risks that may be caused by contractors. Finally, contractors are appraised according to their likely performance, management capability, reputation, resources, progress, competitiveness and activeness and ranked in order of selection priority.	contractor prequalification	CP-DSS

Reference	Abstract	Sourcing approach	Support/model
Nydick and Hill, 1992	Supplier selection may be the single most important phase of the purchasing process. When a supplier selection decision needs to be made, the buyer generally establishes a set of evaluation criteria that can be used to compare potential sources. The basic criteria typically utilized for this purpose are pricing structure, delivery, product quality, and service. For global markets, the set of criteria is expanded to take into account the new variables and risks associated with international business transactions. The Analytic Hierarchy Process (AHP) is a decision-making method for prioritizing alternatives when multiple criteria must be considered. Managerial judgments are used to drive the AHP approach. These judgments are expressed in terms of pairwise comparisons of items on a given level of the hierarchy with respect to their impact on the next higher level. AHP provides a method to compute the consistency of the pairwise comparisons. An example of supplier selection using AHP is provided.	supplier selection	AHP
Olson, 2007	Outsourcing has evolved as a viable means to attain cost savings in organizational information technology. This option, however, involves significant risks. This paper discusses why formal cost evaluation models are difficult to apply in this decision, and demonstrates how multi-criteria methods can be used to support this critical decision.	outsourcing	SMART
Özgen et al., 2008	In this study, an integration of the analytic hierarchy process (AHP) and a multi-objective possibilistic linear programming (MOPLP) technique is developed to account for all tangible, intangible, quantitative, and qualitative factors which are used to evaluate and select suppliers and to define the optimum order quantities assigned to each. A multi-objective linear programming technique is first employed to solve the problem. To model the uncertainties encountered in the integrated supplier evaluation and order allocation methodology, fuzzy theory is adopted. Hence, possibilistic linear programming (PLP) is proposed for solving the problem, as it is believed to be the best approach for absorbing the imprecise nature of the real world. In the supplier evaluation phase, environmental criteria are also considered.	supplier evaluation + order allocation	AHP + MOPLP

Reference	Abstract	Sourcing approach	Support/model
Pai and Basu, 2007	Offshore outsourcing of non-core business process has rapidly evolved as a ubiquitous organisational phenomenon. However, failure to follow a clear, systematic and effective outsourcing strategy to evaluate threats, uncertainties and numerous imponderables can cause global enterprise businesses major setbacks. The reasons for such setback could be largely due to lack of core competency, careful legal planning and due diligence to operating models associated with an outsourcing initiative. This paper attempts to collate and exemplify the distinct qualifying processes accommodating contractual and intellectual property rights and provide a worthwhile debate on intricate legal considerations when structuring multi-jurisdictional outsourcing deals. Importance of legal intervention and due diligence to service agreements is further elevated as, at every phase of an outsourcing arrangement, compliance issues and contractual obligations can affect the success of an enterprise customer and its relationship with their outsourcing service provider.	outsourcing (offshore)	overview of management and legal issues
Platts et al., 2002	The need for companies to develop consistent and competitive manufacturing strategies is now well established. A fundamental question in the development of a manufacturing strategy is the determination of what the company will make and what it will buy, i.e. the make vs. buy (MvB) decision. Historically, such decisions were often made primarily on grounds of cost, however, in recent years there has been an increasing recognition of the strategic implications of these decisions and the need to take into account a wide range of factors other than cost. This paper describes the results of an ongoing study to investigate the factors affecting the making of MvB decisions and the creation of a process to guide industrial companies through making such decisions. The process is based on operationalising a framework which addresses technology and manufacturing processes, supply chain management and logistics, support systems, and costs. Companies following the process are taken through a structured sequence involving identification of triggers for the MvB decision, and the comparison of in-house and external sourcing judged against the areas above. Multi-attribute decision-making is used to provide an overall MvB recommendation. The paper describes the MvB process, its application in an industrial case and concludes with a discussion of its contribution to both academic understanding of the subject, and improvement of industrial practice.	make-or-buy	multi-attribute

Reference	Abstract	Sourcing approach	Support/model
Roberts, 1978	A vendor delivery rating (VDR) model is proposed which is designed to express the cause and effective relationship between order quantity, delivery time, and production efficiency. The basic assumption of the model is that any variation of the vendor, in meeting the agreed order quantity and shipment date will have a negative impact on the customer's production. The model establishes an inverse relationship between the amount of delivery variance and its impact on production efficiency. The VDR model measures various conditions of quantity and time variance between the purchase order item and its corresponding shipment receipt. The VDR system has a number of benefits: 1. Individual vendor performance can be measured over several time periods. 2. The performance of an individual can be measured in relation to other vendors. 3. A performance norm can be established, and vendors can be encouraged to meet it. 4. The ratings serve as a decision tool. 5. Its objectives is to achieve accurate, realistic order, shipping, and delivery practices.	vendor delivery rating	linear weighting
Ronen and Trietsch, 1988	A model-based decision support system (DSS) for purchasing components and materials for large projects is described; it may be used under 2 scenarios: 1. when project planners are looking for a good way to manage the purchasing to minimize the expected costs and the decisions under control are from whom and when to order each item, and 2. when project bidders wish to assess the costs linked with the purchasing decisions that should be considered before making a bid. Both cases take into account out-of-pocket expenses along with lateness and/or expediting penalties. The model underlying the DSS is a stochastic, stationary inventory that emphasizes the variability of lead-time and is embedded in a program evaluation review technique (PERT) environment. The system is designed to help select the best supplier for each item and schedule the placement of orders. These decisions are extremely difficult to make without such a model-based DSS.	supplier selection + order scheduling (large projects)	model-based DSS
Sarkis and Talluri, 2002	The purchasing function for some time now has been receiving increasing importance as a critical supply chain management component. This is mainly due to the significant impact of material costs on profits, increased investments in advanced manufacturing and information technologies, and a growing emphasis on just-in-time production. The critical objectives of purchasing departments include obtaining the product at the right cost in the right quantity with the right quality at the right time from the right source. This requires executing effective decisions concerning supplier selection and evaluation. This article addresses the supplier selection process. This model for evaluation and selection of suppliers considers multiple factors that include strategic, operational, tangible, and intangible measures. The model also allows for input from a variety of managerial decision making levels and considers the dynamic aspects of the competitive environment in evaluating suppliers. An empirical case illustration demonstrates the efficacy of the model. The results provide interesting managerial implications.	supplier selection (supply chain)	ANP

Reference	Abstract	Sourcing approach	Support/model
Soukup, 1987	Effective supplier selection strategies are particularly important in situations where changes can be expected in such areas as design, demand requirements, or delivery dates. Buyers must decide when supplier selection can be treated as routine and how selection should be carried out if the decision requires careful consideration. The key issue in vendor selection is how potential suppliers differ in their ability to accommodate deviations from the contract. The vendor performance matrix, based on the payoff matrix, can be used to analyze and compare vendor performance under several modified scenarios. The matrix has several advantages, including: 1. It facilitates the use of sensitivity analysis. 2. It can be updated periodically. 3. It enables buyers to develop situation-specific supplier selection strategies. Supplier selection decisions can change if the buyer adopts a defensive strategy to optimize its cost position or an aggressive strategy that accepts the risk of higher than necessary procurement costs if volume declines.	supplier selection	matrix
Sucky, 2007	Once the decision to outsource has been made, outsourcing vendors supplying the product or service have to be selected. This paper focuses on dynamic strategic vendor selection. Existing approaches supporting vendor selection neglect the interdependencies in time arising from investment costs of selecting a new vendor and costs of switching from an existing vendor to a new one. These shortcomings of current approaches motivate the research presented in this paper. A dynamic decision making approach for strategic vendor selection based on the principles of hierarchical planning will be proposed.	vendor selection	vendor selection
Timmerman, 1986	A concise and accurate rating system is needed by industrial buyers to provide some objectivity to the vendor selection and monitoring process. A supplier's record of performance is the most important indicator of its ability to add value to a transaction. Of the 3 basic approaches used to evaluate vendor performance, the categorical is the least expensive but is also the least definitive. The cost-ratio method is difficult and expensive to set up. The linear averaging or weighted-point method is very cost-effective and holds the greatest promise for the medium-sized manufacturer. It permits summary of past performance, is flexible for use if the importance of criteria changes, and permits judgment of multiple evaluators. A 7-step outline for developing a linear averaging plan is provided. The process becomes routine once set in motion. The plan can be a useful tool in future negotiation with suppliers.	vendor performance evaluation	linear averaging

Reference	Abstract	Sourcing approach	Support/model
Tsai and Lai, 2007	Because of capacity constraints, the companies who produce joint products have to assess the desirability of further processing joint products beyond the split-off point. Especially in a situation in which market demands exceed the company's production capacity. In order to satisfy customer's orders and maximize total profits, these companies must study the feasibility of expanding capacity or outsourcing the production of parts. The aim of this paper is to develop an ABC joint products decision model which incorporates capacity expansions and outsourcing features, by using a mathematical programming approach. With the model presented in this paper, we can evaluate the comparative benefits of expanding the various kinds of capacity and outsourcing simultaneously. By applying this model, the companies who produce joint products can derive an optimal decision about further processing, capacity expansions or outsourcing.	outsourcing (capacity expansion)	activity-based costing model
Vaidyanathan et al., 1999	In today's competitive environment, it is extremely difficult to successfully produce high quality, low cost products without considering a satisfactory set of suppliers. A useful approach to ensure the reliability of a manufacturer's supply stream is to follow a multiple sourcing policy. Mathematical programming techniques lend themselves nicely by providing optimal solutions to several instances of the problem. However, a recent review of supply selection methods identified very few articles that have proposed mathematical programming techniques to analyze supplier selection decisions. Given the economic importance and inherent complexity associated with the supplier selection problem, a mixed integer programming approach is proposed to solve the supplier selection problem. The model SUPPSEL simultaneously decides the set of suppliers and order quantity allocations among them.	supplier selection + order quantity (supply chain)	mixed integer programming
Venkatesan, 1992	Today manufacturing focus means learning how not to make things - how not to make the parts that divert a company from cultivating its skills, parts its suppliers could make more efficiently. This idea has often been advanced, but few managers have found a way to bring its logic down to earth. My purpose is to do just that, with a new method for making sourcing decisions consistent with a strategy of survival in highly engineered products. Focus on those components that are critical to the product and that the company is distinctively good at making. Outsource components where suppliers have a distinct comparative advantage - greater scale, fundamentally lower cost structure, or stronger performance incentives. Use outsourcing as a means of generating employee commitment to improving manufacturing performance.	make-or-buy	

Reference	Abstract	Sourcing approach	Support/model
Vokurka et al., 1996	Suggests that the evaluation and selection of potential suppliers is becoming a more important and critical decision in today's competitive operating environment. Reveals that many firms are reducing their number of suppliers and the supplier base may provide a company with a strategic competitive advantage. Explains that the supplier selection decision now involves many judgemental factors in addition to the historical selection criteria. Offers a prototype expert system which enables users to evaluate and select a potential supplier based on the strategic importance of the product involved, quantitative data and qualitative factors. The system's early validation results show its potential as an effective decision-making aid.	supplier evaluation and selection	expert decision-support system
Wadhwa and Ravindran, 2007	In any large organization, millions of dollars are spent on outsourcing. Most large organizations are outsourcing those activities that are either not cost efficient if done in-house or not core to their businesses. One of the most critical steps in outsourcing is vendor selection, which is a strategic decision. We model the vendor selection problem as a multi-objective optimization problem, where one or more buyers order multiple products from different vendors in a multiple sourcing network. Price, lead-time and rejects (quality) are explicitly considered as three conflicting criteria that have to be minimized simultaneously. A pricing model under quantity discounts is used to represent the purchasing cost. We present and compare several multi-objective optimization methods for solving the vendor selection problem. The methods include weighted objective, goal programming and compromise programming. The multicriteria models and the methods are illustrated using a realistic example. Value path approach is used to compare the results of different models.	vendor selection	multi-objective optimization + value path approach
J.-J. Wang and Yang, 2007	An ever-increasing trend in today's firms is to exploit outsourcing for those information systems (IS) functions deemed to be outside the company's core competence. Given the multi-attribute nature of IS outsourcing decision, this paper argues that six factors, including economics, resource, strategy, risk, management and quality, should be considered for outsourcing decisions, and proposes the use of analytic hierarchy process (AHP) and preference ranking organization method for enrichment evaluations (PROMETHEE) as aids in making IS outsourcing decisions. The AHP is used to analyze the structure of the outsourcing problem and determine weights of the criteria, and PROMETHEE method is used for final ranking, together with changing weights for a sensitivity analysis. It shows by means of an application that the hybrid method is very well suited as a decision-making tool for the IS outsourcing decision. Finally, potential issues for future research are presented.	outsourcing	AHP + PROMETHEE

Reference	Abstract	Sourcing approach	Support/model
G. Wang et al., 2004	Effective supply chain design calls for robust analytical models and design tools. Previous works in this area are mostly Operation Research oriented without considering manufacturing aspects. Recently, researchers have begun to realize that the decision and integration effort in supply chain design should be driven by the manufactured product, specifically, product characteristics and product life cycle. In addition, decision-making processes should be guided by a comprehensive set of performance metrics. In this paper, we relate product characteristics to supply chain strategy and adopt supply chain operations reference (SCOR) model level I performance metrics as the decision criteria. An integrated analytic hierarchy process (AHP) and preemptive goal programming (PGP) based multi-criteria decision-making methodology is then developed to take into account both qualitative and quantitative factors in supplier selection. While the AHP process matches product characteristics with supplier characteristics (using supplier ratings derived from pairwise comparisons) to qualitatively determine supply chain strategy, PGP mathematically determines the optimal order quantity from the chosen suppliers. Since PGP uses AHP ratings as input, the variations of pairwise comparisons in AHP will influence the final order quantity. Therefore, users of this methodology should put greater emphasis on the AHP progress to ensure the accuracy of supplier ratings.	supply chain (selection)	AHP + PGP
Weber et al., 1991	The vendor selection process has undergone significant changes during the past twenty years. These include increased quality guidelines, improved computer communications, and increased technical capabilities. Given radical changes in the purchasing selection process, it is appropriate to review the past research and to determine its relevance to the supplier selection decision. This paper reviews, annotates, and classifies 74 related articles which have appeared since 1966. Specific attention is given to the criteria and analytical methods used in the vendor selection process. In response to the increased interest in Just-In-Time (JIT) manufacturing strategies, and analysis of JIT's impact on vendor selection is also presented. Finally, conclusions and potential areas for future research are presented.	vendor selection	literature review
Weber et al., 1998	Vendor selection decisions are typically multi-objective in nature. In an environment of competing vendors for a product or service, some vendors are selected and some are not. This paper describes three approaches for the selection and negotiation with vendors who were not selected. Furthermore, it describes how in certain situations two multi-criteria analysis tools, multi-objective programming and data envelopment analysis, can be used together for this selection and negotiation process. The paper describes non-cooperative vendor negotiation strategies where the selection of one vendor results in another being left out of the solution.	vendor selection (non-cooperative vendor negotiation)	multi-objective programming + DEA

Reference	Abstract	Sourcing approach	Support/model
Welborn, 2007	Outsourcing has become a growing trend among many US companies. However, outsourcing does not guarantee business success. There is risk involved and not all sides benefit from such arrangements. The advantages of outsourcing should be carefully weighed against risk and must go beyond evaluating just price. Without a systematic analysis technique to assess risk, much can go wrong: unexpected cost, extended lead times, poor quality or other negative performance variables. Documenting and analyzing risk is an essential element to continued learning and process improvement. It is critical to have an easily understood method to identify and manage risk. Failure mode effects analysis (FMEA) is tool used to collect information related to risk management decisions. FMEA is a well documented, proven technique commonly used to evaluate the risk for failures in product and process designs. Decision makers considering outsourcing options should use the FMEA based outsourcing risk assessment technique. The technique is easily implemented and understood.	outsourcing	FMEA
Welch and Nayak, 1992	Historically, many firms have made sourcing decision - commonly known as make-or-buy decisions - based disproportionately on unit cost, with insufficient regard for strategic or technological issues. This cost-focused approach has led to competitive tragedy for many firms, indeed, entire industries. managers need better tools for evaluating sourcing decisions - tools that can accommodate the long-term, strategic issues. This article presents such a tool, the strategic sourcing model, which augments the traditional cost analysis by considering strategic and technological factors. using this framework, in conjunction with a cost analysis, can help companies make the sourcing decisions that will move them into the leagues of world-class manufacturing and position them for sustained competitive success in the future.	make-or-buy	framework
Yan et al., 2003	The social demands for third-party logistics (3PL) are further developing the model of supply chain management. The analysis of an effective approach for 3PL service supplier evaluation is given in terms of its direct relation to the operational efficiency and benefit of the service-demanding enterprise as well as its supply chain management. An analysis of the traditional academic theoretical results and practical methods for 3PL supplier selection indicates the deficiencies of this approach. In this paper, a case-based reasoning model framework is postulated for a 3PL evaluation and selection system. This work further expands upon the theoretical basis of this system and its reasoning process by discussing the advantages and practical value of this framework.	supply chain (evaluation and selection)	CBR

Reference	Abstract	Sourcing approach	Support/model
D.-H. Yang et al., 2007	Information technology (IT) outsourcing has been one of the critical issues in organization management. Business process outsourcing (BPO) is an advanced type of IT outsourcing, which will be the next big wave in information technology services. Nevertheless, since prior studies have only examined issues related to traditional IS outsourcing, there have been few researches that introduce and discuss the important factors that should be considered in the decision of BPO adoption. This paper identifies factors affecting the BPO decision and structures a decision model using the analytic hierarchy process (AHP) method. By proposing a quantitative decision model, this paper will not only assist management in making better decisions in outsourcing their business processes, but also help them to obtain the most benefits from BPO.	outsourcing	AHP
S. Yang et al., 2007	We studied a supplier selection problem, where a buyer, while facing random demand, is to decide ordering quantities from a set of suppliers with different yields and prices. We provided the mathematical formulation for the buyer's profit maximization problem and proposed a solution method based on a combination of the active set method and the Newton search procedure. Our computational study shows that the proposed method can solve the problem efficiently, and is able to generate interesting and insightful results that lead us to various managerial implications.	order quantity (random yields and stochastic demand)	active set method + the Newton search procedure

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