

Critical Success Factors For Supplier Selection: An Update

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Abstract

For many organizations effective supplier evaluation and purchasing processes are of vital importance. As the pace of market globalization quickens, the number of potential suppliers and the number of factors to consider when selecting suppliers increases. In this paper we present the critical success factors (CSFs) for supplier selection reported in the literature emanating from the seminal work of Dickson and provide an update based on reviewing more than 110 research papers. Our study indicates significant change in the relative importance of various critical success factors in the research reported during 1966-1990 versus 1990-2001. Increased competition and globalization of markets facilitated by Internet-based technologies have combined to dramatically change the ranking of factors while introducing new criteria to the supplier selection process. Based on the results of this study, we conclude that supplier selection criteria will continue to change based on an expanded definition of excellence to include traditional aspects of performance (quality, delivery, price, service) in addition to non-traditional, evolving ones (just-in-time communication, process improvement, supply chain management).

1. Introduction

In a 1993 Focus Study from Center for Advanced Purchasing Studies (CAPS), Carter and Narasimhan (1993) concluded: “The research presented in this report demonstrates dramatically that purchasing issues, strategies, and tactics are just as important as marketing, finance, accounting, and operational issues even though purchasing is first in the value chain and ‘furthest’ from the actual delivery of the product or service to the customer. This is the single most important finding in this study. Purchasing can have a significant impact on quality, customer satisfaction, profitability, and market share.” That conclusion has only been strengthened since 1993 by the advent of Internet commerce and its impact on increasing customer expectations leading to today’s competitive environment in which margins of error have become, simply stated, razor thin.

The industrial purchasing function remains amongst the most critical activities for ensuring the long-term viability of a firm. Pre-dating the rush to Internet commerce, companies have been pursuing improvements in purchasing along several major trends (Kinney, 2000):

- Outsourcing. In order to specialize in the functions where they enjoy unique core competencies, companies have increasingly sought suppliers to perform manufacturing tasks and services formerly performed in-house.
- Global Sourcing. In order to lower costs, companies are increasingly looking for low-cost countries not only to outsource some activities, but also to move some purchases from domestic to foreign suppliers.
- Supply Chain Optimization. In order to drastically reduce the amount of inventory being held for contingencies along the entire length of a supply chain, companies are seeking suppliers to achieve true “build to order” capability throughout the supply chain by sharing information and reducing guesswork about the needs, thereby collectively reducing inventory carrying costs, obsolescence, spoilage, and overstocks.

- **Supplier Consolidation.** In order to gain volume purchasing power and reduce administrative and coordination costs, companies have been striving to consolidate to fewer suppliers.

Not surprisingly, a common thread in the above approaches to improve purchasing is the supplier selection decision problem. Any mistake in this decision can easily render the approach ineffective and could even adversely affect the stability of the organization in today’s turbulent competitive environment with little or no tolerance for errors.

In the US, the total dollar magnitude of purchases by businesses exceeds the gross national product (Tully, 1995). Purchasing transactions typically amount to 55 percent of an organization’s revenue. Given that purchasing involves large cash flows and has a significant impact on quality, customer satisfaction, profitability, and market share, the process of selecting suppliers has received considerable attention in purchasing circles. And, as more companies shift their paradigm from a zero sum game of supplier-buyer bargaining power to one based on a win-win proposition for developing long-term relationships aimed at improving coordination of supplier networks throughout the supply chain, the supplier selection problem becomes an increasingly strategic decision confronting the management of the firm.

In this paper we present the critical success factors (CSFs) for supplier selection reported in the literature. Specifically, we re-examine the CSFs reported in the seminal work of Dickson (1966) and provide an update based on reviewing more than 110 research papers. We also posit reasons for the increase or the decrease in the importance of a particular CSF and examine the impact of the Internet on the supplier selection process.

2. Critical Success Factors For Supplier Selection

The identification and analysis of criteria for selection and evaluation of vendors has been the focus of attention for many academicians and practitioners. In his seminal work, Dickson (1966) conducted a questionnaire survey mailed to about 300 commercial organizations, primarily manufacturing firms. The purchasing managers of these firms were asked to identify factors that were important for selecting suppliers. His findings were divided into two categories: vendor selection practices by firms and vendor selection practices by individuals.

Table 1 summarizes his results pertaining to factors commonly used to rate potential suppliers by firms. It identifies quality, price, and delivery as the most critical factors in the supplier selection process.

To study vendor selection practices by individual decision makers, he selected four unique purchasing scenarios encompassing markedly different products and situations and a list of 23 factors reported in the purchasing literature as important to the supplier selection decision problem. Each respondent (purchasing manager) was asked to consider each scenario and rate the importance of each of the factors listed using a scale of 0-4 (4 representing extreme importance and 0 indicating slight or no importance). Table 2 depicts the results.

A readily noticeable difference between the two tables is the reduced ranking of service in the latter. This could have been the result of the fact that the selected purchasing scenarios were atypical with regard to service requirements. Indeed, Table 3 points out the influence of the item/service being purchased on the relative importance of various factors in the supplier selection decision problem.

Table 1. Factors Used In Vendor Rating Systems (Dickson, 1966)

Factor	Percentage Of Systems Using The Factor
Quality	96.6
Price	93.9
Delivery	93.9
Service	81.8
Technical Capability	63.6
Financial Strength	51.5
Geographical Location	42.4
Reputation	42.4
Reciprocal Arrangements	15.1
Other Factors	12.1

Table 2. Aggregate Factor Ratings (Dickson, 1966)

Number	Factor	Mean	Relative Importance
1	Quality	3.508	Extreme Importance
2	Delivery	3.417	
3	Performance History	2.998	Considerable Importance
4	Warranties & Claims Policies	2.849	
5	Production Facilities and Capacity	2.775	
6	Price	2.758	
7	Technical Capability	2.545	
8	Financial Position	2.514	
9	Procedural Compliance	2.488	Average Importance
10	Communication System	2.426	
11	Reputation and Position in Industry	2.412	
12	Desire for Business	2.256	
13	Management and Organization	2.216	
14	Operating Controls	2.211	
15	Repair Service	2.187	
16	Attitude	2.120	
17	Impression	2.054	
18	Packaging Ability	2.009	
19	Labor Relations Record	2.003	
20	Geographical Location	1.872	
21	Amount of Past Business	1.597	
22	Training Aids	1.537	
23	Reciprocal Arrangements	0.610	Slight Importance

Table 3. Most Important Factors By Situation (Dickson, 1966)

Importance Rank	Case A Paint	Case B Desks	Case C Computers	Case D Art Work
1	Quality	Price	Quality	Delivery
2	Warranties	Quality	Technical Capability	Production Capacity
3	Delivery	Delivery	Delivery	Quality
4	Performance History	Warranties	Production Capacity	Performance History
5	Price	Performance History	Performance History	Communication System

Dickson reconfirmed his earlier observation that price was not a consistently important factor in the vendor selection process. Similarly, technical capability, production capacity, and warranties while considered by the respondents to be very important for some of the purchases were also deemed unworthy of much consideration in other instances. He finally concluded that three factors were crucial in the choice of vendors: the ability to meet quality standards, the ability to deliver the product on time, and performance history. He also made a few generalizations about the importance of factors in the vendor selection process. The more complex the product/service being purchased, the more factors are likely to be considered, and in these cases, price is likely to be relatively unimportant. Conversely, in purchases of ordinary products like nuts and bolts, price is generally the primary factor that is considered. Thus he concluded that the nature of the item to be purchased has a major influence on the factors that are considered when selecting a supplier. As such, he doubted the credibility of one universal system for vendor analysis that could be appropriate for all kinds of purchasing decisions.

3. Critical Success Factors For Supplier Selection: 1966-1990 And 1990-2001

Dickson's pioneering work was re-visited by Weber et al. (1991) where 76 articles published between 1966 (year of Dickson's study) and 1990 were categorized based on Dickson's 23 vendor selection criteria. Considering the extensive nature of their study and the structured approach adopted, it was appropriate to extend their results to encompass research on the supplier selection decision problem published between 1990 and 2001. Including the journal articles from Weber et al., 113 articles were reviewed and the findings are presented in this section.

Table 4 presents a list of the journals in which the articles were published. Just as Weber et al. indicated, the majority of them (37%) appeared in the *International Journal of Purchasing and Materials Management*. It is noteworthy that relatively less attention has been paid to this topic by operations research and decision science journals.

Table 4. Publication Outlets For Research Papers Reviewed

Journal	Number Of Papers 1966-1990		Number Of Papers 1966-1990	
Computers and Industrial Engineering			1	3%
Computers and Operations Research	2	3%	1	3%
Decision Sciences	2	3%	2	5%
European Journal of Operational Research	1	1%	1	3%
Harvard Business Review	1	1%		
IIE Transactions			1	3%
Industrial Marketing Management	2	3%	1	3%
Integrated Manufacturing Systems			1	3%
Interfaces	1	1%		
International Journal of Operations and Production Management	2	3%	3	8%
International Journal of Physical Distribution and Logistics Management			4	10%
International Journal of Production Economics			1	3%
International Journal of Production Research	3	4%		
International Journal of Purchasing and Materials Management	33	45%	9	23%
Journal of Applied Business Research			2	5%
Journal of Business Logistics	3	4%		
Journal of Marketing	4	5%		
Journal of Marketing Research	2	3%		
Journal of Operational Research Society	1	1%		
Journal of Operations Management	1	1%	2	5%
Journal of Purchasing	5	7%		
Journal of Retailing	1	1%		
Journal of Small Business Management			1	3%
Journal of Supply Chain Management			3	8%
Management Science	5	7%		
Omega			1	3%
Operational Research Quarterly	1	1%		
Production and Inventory Management Journal	3	4%	1	3%
Purchasing			1	3%
Purchasing and Supply Management			1	3%
Supply Chain Management: An International Journal			2	5%

Table A in the Appendix categorizes all articles based on the 23 vendor selection criteria identified numerically in Table 2. The articles are listed by author and year of publication. A “1” confirms the recognition of a criterion in the supplier selection research reported in the article. The final column named ‘Other’ indicates the total number of criteria used in the article that cannot be classified by any of Dickson’s 23 vendor selection criteria. It is important to note that as stated by Weber et al., this review is entirely based on academic literature while Dickson’s study was based on a survey of purchasing agents. Hence any comparisons between the two studies should be done with the realization that the two studies were based on two different ‘populations’. (Weber et al., 1991)

From Table A it can be determined that out of 113 papers, 86 papers have considered more than one evaluation criterion. Therefore, 76% of the papers reviewed consider the supplier selection problem as a multiple criteria decision problem. Table 5 lists the number of articles in which each criterion was addressed and provides a comparison of the factors considered in Weber et al. study and those in this study. Figure 1 presents a graphical comparison of the two studies.

Table 5. Comparison Of Factors: 1966-1990 And 1990-2001

Factor	1966-1990		1990-2001		Overall	
	Papers		Papers		Papers	
Quality	40	54%	31	79%	71	63%
Delivery	45	61%	30	77%	75	66%
Performance History	7	9%	4	10%	11	10%
Warranties & Claim Policies	1	1%	0	0%	1	1%
Production Facilities and Capacity	25	34%	10	26%	35	31%
Price	55	74%	26	67%	81	72%
Technical Capability	19	26%	11	28%	30	27%
Financial Position	8	11%	7	18%	15	13%
Procedural Compliance	2	3%	2	5%	4	4%
Communication System	3	4%	4	10%	7	6%
Reputation and Position in Industry	9	12%	1	3%	10	9%
Desire for Business	2	3%	0	0%	2	2%
Management and Organization	10	14%	7	18%	17	15%
Operating Controls	5	7%	0	0%	5	4%
Repair Service	7	9%	11	28%	18	16%
Attitude	9	12%	5	13%	14	12%
Impression	4	5%	2	5%	6	5%
Packaging Ability	5	7%	0	0%	5	4%
Labor Relations Record	3	4%	1	3%	4	4%
Geographical Location	15	20%	2	5%	17	15%
Amount of Past business	1	1%	0	0%	1	1%
Training Aids	3	4%	0	0%	3	3%
Reciprocal Arrangements	3	4%	2	5%	5	4%

Significant changes in relative importance of such factors as Repair Service and Geographical Location for supplier selection can easily be noted in Figure 1. In Table 6, we specifically show the percentage change in relative importance of the 23 criteria considered in Weber et al. study and our study. The negative numbers indicate a decrease in importance.

Figure 1. Comparison Of Factors: 1966-1990 And 1990-2001

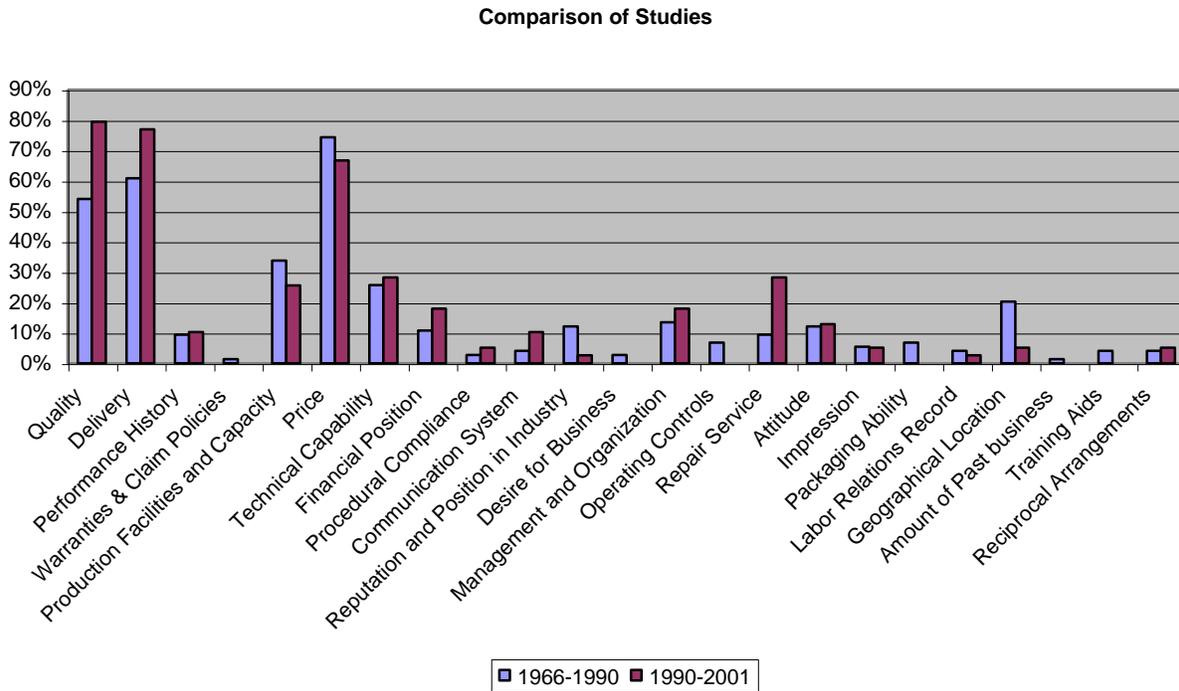


Table 6. Percentage Change In Relative Importance Of Factors In The Two Studies

Factor	Percentage Change in Importance 1966-1990 versus 1990-2001
Repair Service	198%
Communication System	153%
Procedural Compliance	90%
Financial Position	66%
Quality	47%
Management and Organization	33%
Delivery	26%
Reciprocal Arrangements	26%
Technical Capability	10%
Performance History	8%
Attitude	5%
Impression	-5%
Price	-10%
Production Facilities and Capacity	-24%
Labor Relations Record	-37%
Geographical Location	-75%
Reputation and Position in Industry	-79%
Warranties & Claim Policies	-100%
Desire for Business	-100%
Operating Controls	-100%
Packaging Ability	-100%
Amount of Past business	-100%

Table 7 provides the current as well as the previous rankings of the different vendor selection criteria. The column 'Current Rank' indicates the position that each criterion holds in this study (based on the number of papers that criterion occurred in) and the column 'Previous Rank' refers to the rank the criterion held in Weber et al. study. The table also includes new criteria that were not present in the original list of 23 (Dickson, 1966).

Table 7. The Present And Past Ranking Of Vendor Selection Criteria

Current Rank	Previous Rank	Factor
1	3	Quality
2	2	Delivery
3	1	Price
4	10	Repair Service
5	5	Technical Capability
6	4	Production Facilities and Capacity
7	9	Financial Position
8	7	Management and Organization
9	New	Reliability
10	New	Flexibility
11	8	Attitude
12	13	Communication System
13	10	Performance History
14	6	Geographical Location
15	New	Consistency
16	New	Long-Term Relationship
17	14	Procedural Compliance
18	12	Impression
19	13	Reciprocal Arrangements
20	New	Process Improvement
21	New	Product Development
22	New	Inventory Costs
23	New	JIT
24	New	Quality Standards
25	New	Integrity
26	New	Professionalism
27	New	Research
28	New	Cultural
29	8	Reputation and Position in Industry
30	13	Labor Relations Record
Passé	11	Operating Controls
Passé	11	Packaging Ability
Passé	13	Training Aids
Passé	14	Desire for Business
Passé	15	Amount of Past Business
Passé	15	Warranties & Claims Policies

4. Discussion Of Results

Reliability, Flexibility, Consistency, and Long-Term Relationship are four significant new entrants into the list of critical success factors for supplier selection. On the other hand, Warranties and Claim Policies, Amount of

Past Business, Desire for Business, and Training Aids are among the factors that have become passé. Considering the change in relative importance of the various factors a number of observations can be made:

4.1. Quality

Quality is generally defined as conformance to requirements or fitness to use. But, like a multi-faceted diamond, quality may be perceived through five principal aspects: 1) transcendent quality is an idea, a condition of excellence; 2) product based quality is tied to product attributes; 3) user based quality reflects fitness to use; 4) manufacturing based quality is conformance to requirements; and 5) value based quality is the degree of excellence at an acceptable price. Whatever the perspective, quality has two major components: quality of conformance—quality is defined by the absence of defects; and quality of design—quality is measured by the degree of customer satisfaction with a product's characteristics and features. (APICS, 1999)

In supplying products or services there are three fundamental parameters that determine their saleability. They are price, delivery, and quality. Customers require products and services of a given quality to be delivered by, or be available by, a given time, and to be at a price that reflects value for money. These are the needs of customers. An organization will survive only if it creates and retains satisfied customers and this can only be achieved if the products or services meet customer needs and expectations. While price is a function of cost, profit margin, and market forces, and delivery is a function of the organization's efficiency and effectiveness, quality is determined by the extent to which a product or service successfully serves the purpose of the user during usage (not just at the point of sale). Price and delivery are transient features whereas the impact of quality is sustained long after the attraction or the pain of price and delivery has subsided. Therefore, the fact that quality is on top of the list of critical success factors for supplier selection should not be surprising.

4.2. Delivery

Along with quality, another factor that is considered a basic prerequisite for supplier selection is delivery. Even after 36 years since Dickson's study conforming to quality specifications and meeting delivery deadlines remain the most important supplier selection criteria. In a fundamental sense, these form the *threshold* criteria that buying firms apply to all suppliers before they can be considered as strategic partners in the buyer-supplier relationship (Choi, 1996). They have emerged as order qualifiers to the extent that if suppliers cannot demonstrate acceptable performance in these two areas, they will be dropped as potential candidates during the screening phase itself. One possible explanation for the continuing high ranks that these two criteria receive is that conformance to specifications in these two areas will ensure minimization of disruptions in the buyer's manufacturing operations thereby ensuring uninterrupted production.

4.3. Repair Service

Even as late as early 1980s, suppliers wielded the greatest bargaining power in the buyer-seller relationship. Many markets were characterized by having few suppliers practicing mass manufacturing and marketing. However, since the early 1980s there has been a marked improvement in the bargaining power of the buyer. With customers becoming much more knowledgeable in terms of defining their requirements and because of the increasing competition faced by the suppliers, customers have begun to dictate the terms of purchasing. The companies that used to thrive on mass production, stability, and growth are no longer guaranteed continued success in a world where customers, competition, and change, demand flexibility and quick response. Today, the overriding objective or even prerequisite for any organization to thrive in a competitive marketplace is to focus on customer satisfaction. All other factors being equal, it is inevitable that a buyer will favor the supplier that offers better customer service. Easy accessibility, fast response, flexibility, the technical expertise to support problems, quality of service provided, and above all satisfaction with the product or the service provided are the many dimensions of good customer service.

4.4. Technical Capability

The rapid pace of introduction and deployment of new technologies has contributed to the increased importance of an evaluation of the technical capability of a prospective vendor in the supplier selection decision problem. The buyer is not only concerned about the current technology utilized by the supplier but also about its future technological capability. This includes a supplier's design capability as well as the speed with which it can take an item from the development stage into the production stage. Related to the assessment of future technological capabilities is an evaluation of a potential supplier's ability to participate in, and contribute to, the design of the buying firm's new products. Similarly, the supplier's ability to move fast, so that new products can be introduced more quickly, becomes an important asset for the buying organization.

4.5. Financial Position

An assessment of the financial stability and fiscal outlook of the supplier is a factor gaining in importance in the growing trend of forging supplier-buyer partnerships. Both buyers and sellers are looking for partners that are viable, ongoing concerns that will contribute to the relationship both for the present and in the future. A supplier on financially unstable footing will have much more difficulty contributing to the partnership venture, as it must focus its efforts on improving its financial soundness. Hence, both suppliers and buyers are becoming more mindful of the financial position of their potential partners in their decision making (Ellram, 1990).

4.6. Management and Organization

The critical success factor of Management and Organization encompasses several intangible elements: management attitude; outlook for the future; feeling of trust; compatibility across levels and functions of buyer and supplier firms; and the supplier's organizational structure and personnel. Of course, one of the most difficult factors to rate with any degree of precision is the feeling of trust. Firms described this as a "gut feel" that the supplier firm will hold up its end of the partnership and the two firms will be able to work together well. The management attitude and outlook for the future is the strategic direction that the supplier firm should take, and its willingness to modify that direction to fit the strategy of the buying firm. Goal congruence is a vital factor because a partnership is designed to be a continuing relationship. While strategies may shift over time, an initial fit between the buyer and the seller in terms of strategic outlook and future plans is seen as a prerequisite to establishing a close, long-term relationship. Top management fit is also seen as critical since top management sets the direction for the firm, and it is likely to set the tone of key relationships.

4.7. Geographical Location

With the advances in logistics and information technology, business has transcended geographical boundaries. The globalization of the world economy has resulted in an increase in the number of firms that have shifted their concentration on domestic sourcing to development of supplier bases around the world (Min, 1993). The relaxation of trade barriers and the awareness of the relative strengths of the diverse geographical regions of the world have led to this increased interest in international sourcing. As information technology continues to introduce more advanced means for closer coordination of supply chains, we can anticipate further reduction in the importance of the geographic location of the vendor in the supplier selection decision problem.

5. The Impact Of The Internet On The Supplier Selection Decision Problem

A major development since Weber et al conducted their study has been the popularization of the Internet both as a communication medium as well as an outlet for publishing research. As such, we felt that it was important to include Internet-based outlets in this study. To that end, a search was conducted in the websites of leading corporations as well as e-magazines and the results have been tabulated in Table 8.

Table 8. Critical Success Factors For Supplier Selection Obtained In The Internet Survey

Rank	Factor	Number of Occurrences
1	Price	10
2	Quality	8
2	Technical	8
3	E-Commerce	7
4	Performance History	4
4	Service	4
5	Adaptability	3
5	Financial Stability	3
5	Reliability	3
5	Size	3
5	Reputation	3
6	Flexibility	2
6	Environmental Responsibility	2
6	Lead Time	2
6	Specialization	2
6	Customer Service	2
6	Quality Standards	2
6	Communication	2
6	Technology	2
6	Long-Term Relationship	2

Although the critical success factors cited are very much consistent with the earlier results from the academic literature, one very important addition is *e-procurement* and *e-commerce*. The results of Purchasing Magazine's broad-based survey of purchasing professionals reveal that most industrial purchasing professionals perceive the Internet to be a supply management tool that can save sourcing time, efficiently locate new suppliers, reduce costs, greatly improve communication with suppliers, help track supplier performance, and free them for higher level, more value-added work (Purchasing, 1999). They express little doubt that the Internet will enable them to integrate their entire supply chains and make major contributions to company profitability and competitiveness. They believe that widespread use of e-procurement will enable manufacturing companies to move closer to pull-type demand systems, thereby minimizing inventory carrying costs, speeding up cycle times, and enabling their products to match end-users' needs more closely.

Indeed, Internet-based e-commerce technologies collapse physical distance, accelerating the transition to a truly global economy, which in turn forces businesses to become even more competitive. In a fundamental sense, the Internet provides a foundation upon which most, even all, purchasing activities can be performed and appropriate data about them be captured. As such, today's purchasing managers expect their suppliers to be willing to trade through the web utilizing the full range of possibilities for process improvement made feasible by e-commerce technologies. In fact, according to Brunelli (2000), incumbent suppliers who do not invest in e-commerce technology are more likely to be replaced by suppliers that can or will.

6. Summary And Conclusions

The supplier selection problem is of vital importance for operation of every firm because the solution of this problem can directly and substantially affect costs and quality. Indeed, for many organizations effective supplier evaluation and purchasing processes are critical success factors. A great deal of research has been conducted to

determine what criteria should be used to evaluate suppliers. In practice, any set of criteria must be considered in light of real-life constraints, making the supplier selection a complicated decision problem that involves balancing many tradeoffs and satisfying conflicting desiderata.

From a decision support system perspective, the research on the supplier selection problem can be divided into two parts. First, multi-attribute decision making models that give grades to suppliers on a set of criteria, and then use a weighting scheme to arrive at a supplier score. Second, mathematical programming techniques that model the constraints and an objective function to select the optimal supplier. The grading method is easy and intuitive but remains simplistic in that it does not consider any constraints explicitly. On the other hand, mathematical programming methods accommodate both constraints and supplier selection criteria, but must make restrictive assumptions to reduce inordinate complexity. As such, supplier selection criteria play an integral role in both approaches.

In this paper we considered the criteria for supplier selection reported in the literature. Specifically, we re-examined the criteria reported in the seminal work of Dickson (1966) and provided an update based on reviewing more than 110 research papers. Our study indicated significant change in the relative importance of various critical success factors in the research reported during 1966-1990 versus 1990-2001. Increased competition and globalization of markets facilitated by Internet-based technologies have combined to dramatically change the ranking of factors while introducing new criteria to the supplier selection process. Based on the results of this study, it seems appropriate to conclude that supplier selection criteria will continue to change based on an expanded definition of excellence to include traditional aspects of performance (quality, delivery, price, service) in addition to non-traditional, evolving ones (JIT communication, process improvement, supply chain management).

We also expect further erosion of the ranking of price (the number one vendor selection criterion in the research prior to ours) in future research on the supplier selection problem. Purchasing via the Internet has transformed the processes of buying, selling, and supplier selection. For commodity markets, including high-tech parts and products, electronic auctioning is not only challenging price, but also inducing a profound change in the way purchasing managers work with suppliers. Transparent and rigorously-defined criteria in an electronic auction open up established sourcing relationships to determined, underdog suppliers, and lead to pricing bandwidths heretofore unthinkable in conventional negotiation processes. Because such price reductions in supplies is ultimately passed to customers, eProcurement will drive competitiveness throughout the global supply chain allowing factors other than price to assume greater importance in the supplier selection problem. 

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Appendix

Table A. Classification Of Research Papers Based On Dickson’s 23 Criteria

Author(s)	Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Other
Akinc	1993	1	1				1																		
Ansari et al	1986	1	1				1										1				1				
Ansari et al	1988	1	1				1										1		1		1				
Anthony et al	1977		1				1																		
Banerjee	1986						1																		
Banerjee	1986		1				1																		
Barbarosoglu et al	1997	1	1			1	1	1	1					1			1								3
Bender et al	1985	1	1			1	1																		
Benton	1983						1																		
Benton	1985						1																		
Benton	1985						1																		
Benton et al	1982						1																		
Benton et al	1990	1	1													1									
Bernard	1989	1	1											1		1									
Bragg et al	1982		1			1																			
Browning et al	1983		1			1	1	1																	
Buffa et al	1983	1	1	1		1																			
Burton	1988	1	1			1	1	1						1	1					1	1	1			
Cardozo et al	1971	1	1			1						1									1				
Carter	1995					1	1	1									1								2
Chakravarthy et al	1988					1																			
Chapman	1989	1	1			1																			
Chapman et al	1990	1	1																						
Choi et al	1996	1	1					1			1					1		1							3
Cooper	1977		1																						

Monczka et al	1988	1	1			1					1		1					
Moore et al	1973	1	1															
Motwani et al	1999	1	1			1	1											
Mummalaneni et al	1996	1	1			1							1	1				1
Narasimhan	1983	1	1			1												
Narasimhan et al	1986					1	1											
Newman	1988	1																
Newman	1988	1	1			1	1	1						1		1		
Newman et al	1988					1												
Nydick et al	1992	1	1			1							1					
Pan	1989	1	1			1												
Payne	1970							1										
Porter	1992	1	1			1	1	1	1	1			1					1
Roberts	1978		1															
Ronen et al	1988		1			1												
Rubin et al	1983					1												
Sheth	1973	1	1			1	1	1		1			1	1				1
Shore	1981	1	1			1												
Smytka et al	1993	1	1			1												1
Soukoup	1987	1	1			1	1	1	1		1	1		1		1		
Thompson	1991						1	1					1					1
Timmerman	1987	1	1	1		1	1											
Tracey et al	2001	1	1	1		1												1
Treleven	1987	1	1			1	1											
Tullous et al	1994	1	1			1												1
Turner	1988					1	1											
Verma et al	1998	1	1			1												1
Vokurka et al	1996	1	1	1		1	1			1	1			1				1
Vonderembse et al	1999	1		1		1												1
Wagner et al	1989	1	1			1			1				1					
Weber et al	1991	1	1			1	1											
Weber et al	1993	1	1			1												
Weber et al	2000		1			1												0
Wieters	1976					1	1	1		1	1	1			1			
Willis et al	1989	1	1			1	1	1					1	1				2
Wilson	1994	1	1			1							1					
Wind et al	1968	1	1	1		1	1		1	1					1		1	