An Empirical Investigation of Tools and Joint Practices Used in Managing Customer-Supplier Relationships

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ABSTRACT

The purpose of this research was to study customer-supplier relationships, and particularly their partnerships, to help managers and practitioners successfully design, develop, implement and deploy tools and joint practices for their upstream systems. To achieve this purpose, a total of 1,811 (potential mailed survey questionnaire respondents) and 7 (structured interviewees) managers who are responsible for purchasing, sales/ marketing, quality-related, and production- or operations-related functions of U.S. private manufacturing companies in SIC 35, 36, and 37 were used to collect qualitative and quantitative data.

Using 172 usable mailed survey questionnaire responses (response rate: 9.78%) and qualitative data from the structured interviews, the following major findings were derived:

- Four tools/joint practices most frequently used in customer-supplier relationships were supplier certification/verification, joint problem-solving teams, quality audits, and Just-In-Time production and delivery,
- Five tools/joint practices that have been used most effectively were ISO 9000 and/or QS 9000 and/or Baldrige criteria, quality audit, JIT production/delivery, joint planning, and joint problem-solving teams,
- Five tools/joint practices that have been most internalized were ISO 9000 and/or QS 9000 and/or Baldrige criteria, quality audit, JIT production/delivery, joint problem-solving teams, and supplier or customer performance measurement systems,
- Overall perceived organizational performance improvement was 25% (30% quality improvement, 21% cost reduction, and 26% cycle time reduction).

In addition to these findings, eight hypothesized relationships were tested using two independent variables (joint use of specific tools and joint use of practices) and four

dependent variables (informed partners, role integrity, conflict resolution, and mutuality). The results showed that customer and supplier companies do not share the same experience with respect to the relationships between the two independent variables and conflict resolution.

Using these findings, a set of practices was proposed as a means for further improving specific organizational performance dimensions and providing a mechanism to better share the consequences of joint action.

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CHAPTER 1. INTRODUCTION

1.1   Overview of This Research

Research on customer-supplier relationships, or organizational upstream[1] management, can be divided into three branches: research in the marketing discipline (called relationalism); research in industrial engineering; and research in the purchasing discipline. Although the results and contributions made by these three branches have been widely accepted and adopted by many contemporary researchers, two important points that do not seem to be sufficiently addressed are (1) the enumeration of the specific tools or joint practices that have been used in joint action[2] between customer and supplier companies, and (2) exploration of the relationship between specific tools/joint practices[3] and the outcomes, called *shared results* in this research, of using them.

In most studies of relationalism, researchers have focused on key factors such as commitment, trust, two-way communication between a customer and a supplier organization, and other factors that contribute to more desirable customer-supplier relationships (Boyle, Dwyer, Robicheaux, & Simpson, 1992; Ganesan, 1994; Heide & John, 1990 and 1992; Kaufmann & Stern, 1988 and 1992), hence, the term *relationalism*. What is missing from this field is an attempt to identify specific tools or joint practices to improve customer-supplier relationships.

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[1] Organizational upstream systems include customers, suppliers, vendors, etc. that provide organizations with any kind of input, including materials (components, parts, etc.) or information (requirements, expectations, and specifications), for value-adding activities.

[2] Joint action (between customer and supplier) is defined as inter-penetration of organizational boundaries in two ways: joint use of (1) specific tools such as Quality Function Deployment and Just-In-Time delivery, and (2) joint practices such as joint problem-solving teams and information exchange (Guetzkow, 1966; Laumann, Galaskiewicz, & Marsden, 1978).

[3] In this study, joint action is characterized by joint use of (1) specific tools and/or (2) joint practices that include meetings, joint planning, information sharing, etc., for which specific tools are not necessarily used. (For more information on distinction between specific tools and joint practices, see Section 1.11.)

On the other hand, studies done within the purchasing discipline have addressed identification of tools and joint practices to improve the performance of customer-supplier relationships (Billesbach, Harrison, & Simon, 1991; Cayer, 1990; Campbell, 1985; Johnson, 1989; Morgan & Zimmerman, 1990). For example, Ansari and Modarress (1994) examined the joint use of Quality Function Deployment (QFD) by both customer and supplier organizations that caused closer working relationships in resolving any inconsistency in customers' operating procedures. Also, Stuart and Mueller (1994) examined joint problem-solving teams that were found to improve customers' productivity by 7.5%. What these studies are missing, however, is the link between the specific tools and joint practices studied and the outcomes of using them, or *shared results*. Not only using tools and joint practices to improve customer-supplier (or *q1-q3*[4]) relationships, but proactively managing the shared results of using them will further improve the performance of the two organizations.

In sum, several gaps identified in the literature – insufficient enumeration of tools or joint practices and exploration of the shared results from tools and joint practices – lead to the need for further research on upstream system management in order to:

- identify tools and joint practices used in q1-q3 relationships;
- evaluate the level of effectiveness and internalization of tools and joint practices identified; and
- investigate the relationship between the tools/joint practices used and shared results.

To address these issues, this study examines the relationship between q1-q3 joint action (tools and joint practices) and the shared results of q1-q3 joint action. To observe and measure q1-q3 joint action and shared results and to analyze the relationship between the two, this research uses two sets of variables. First, joint action is defined as the joint use

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[4] Authors whose works are cited here and hereafter do not use the specific words q1 and q3. However, the terms q1 and q3 are used to represent supplier (or seller) and customer (or buyer) respectively. This is to avoid wordiness and the confusion caused by using different sets of words to indicate the same thing. In other words, these terms are used for the purpose of clarity and succinctness. These terms are used within a quality checkpoint framework developed at Virginia Tech by Sink (1989), and are described in Section 1.2.

of specific tools and/or joint practices. Second, four measures[5] – role integrity, conflict resolution, flexibility, and mutuality – are used to observe and measure the shared results, which are the outcomes of q1-q3 joint action. By examining how the shared results measures are perceived and managed by customers and suppliers and by examining the effects of tools and joint practices, this research addresses the three issues defined above.

To collect quantitative and qualitative data on the variables briefly defined above, two research methods are used: a mailed survey questionnaire and structured interviews. The quantitative data is obtained from the mailed survey questionnaire, completed by managers of selling, buying, and production- or operations-related sections of companies in three industry groups (e.g., Standard Industrial Classification (SIC) 35 [Industrial equipment and machinery], 36 [Electronic and electric equipment], and 37 [Transportation equipment]). The qualitative data is obtained from structured interviews of (a) managers of supplying and buying sections of companies that have won the Commonwealth of Virginia's *Senate Productivity and Quality Award (SPQA[6]),* private sector manufacturing category, and also from other sources, such as members of (b) the National Association of Purchasing Management (NAPM) and (c) the American Society for Quality (ASQ) in the Roanoke-Radford Section. Data obtained from the structured interviews are analyzed to supplement and illuminate findings from quantitative analysis using the mailed survey questionnaire. The two research methods are combined in this study to produce findings that are both empirical and grounded in practical experience.

This research has three characteristics. First, this research is non-experimental and primarily uses two sources of data – a mailed survey questionnaire and structured interviews – to form the basis for the construction of assertions about q1-q3 joint action and the shared results from joint action. Qualitative data from the structured interviews are used to support the results derived from the mailed survey questionnaire. The conclusions are drawn and generalized to the extent possible. Therefore, this research is

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[5] The four measures are defined in detail in Section 1.12.
[6] See Appendix B for more information about the SPQA and its selection criteria.

inductive, rather than deductive.

Second, this research is also descriptive in that it focuses upon the description of specific tools and joint practices used in q1-q3 relationships. A descriptive research method is appropriate for data derived from observational situations such as mailed survey questionnaires and interviews, as are utilized in this research. Although descriptive research methods rely on observation for collecting data, those data must be organized and presented systematically so that valid and accurate information can be drawn from them.

Third, this research is also applied research. Unlike basic research in which knowledge is a primary end in itself and the researchers' major interest is in discovering the central factors (or truth) in a problem (Goode & Hatt, 1952; Patton, 1990), this research uses past and present theories and assertions on q1-q3 relationships to understand how current organizations manage upstream systems. Sharing these findings will help other researchers and practitioners clarify the roles and scope of upstream management, especially q1-q3 joint action, by addressing the gaps identified earlier, and thus, extending the body of knowledge on q1-q3 joint action.

1.2   *Brief Background of q1-q3 Partner Relationships*

This section describes three perspectives on definitions of q1-q3 partnerships and factors contributing to q1-q3 partnerships.

1.2.1   Perspectives on definitions of q1-q3 partnership

Marketing perspective: "*The focus of the management of upstream systems is on* the relationship between two organizations in which two organizations make a substantial commitment to developing a collaborative effort and common orientation toward their individual and mutual goals" (Spekman & Sawhney, 1990, p. 1; *emphasis added*).

Purchasing perspective: "Concurrent engineering calls for the consideration and inclusion of product design attributes, such as manufacturability, procurability, reliability, maintainability, schedulability, marketability, and the like, in the early stages of product design. In this environment, planned purchasing contributions, along with a number of other factors, are included in the early stages of new product design. Purchasing inputs can often assist product and manufacturing engineers by providing opportunities to

improve product design or reduce the time and costs associated with production. The purchasing function can contribute to the design process in the following ways: developing specifications, providing interchangeable/substitutable parts, and conducting value analysis" (Dowlatshahi, 1992, p. 21).

Management Systems Engineering (MgtSE[7]) perspective: **"**Quality management activities of organizational upstream systems include selecting and managing upstream systems by developing and maintaining standards, specifications, and open communication channels with supplier organizations *(internal/external q1)* from which organizations *(q3)* receive inputs" (Sink, 1989, p. 8*; italics added*).

A review of findings from different perspectives related to upstream management will help clarify the focus of this research. The three perspectives above focus on using specific tools or joint practices to improve q1-q3 relationships. Upstream management can be considered differently in each perspective. However, some common foci of the management of upstream systems can be found in all of the above three perspectives: *the importance of and necessity for a closer relationship or partnership between q1 and q3 organizations.* This relationship has become a necessary condition for today's business world in which many organizations try to remain competitive by identifying and measuring customer requirements, creating supplier partnerships, using cross-functional teams, cutting production costs, and increasing the quality of their products (Hackman & Wageman, 1995). See Figure 1-1 for a graphical representation of upstream systems and Table 1-1 for descriptions of q1 and q3 in a large organizational context.

On the other hand, one distinction between the MgtSE definition of upstream management and definitions provided by marketing and purchasing perspectives is that the MgtSE definition of upstream management emphasizes *how to design, develop, and use*

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[7] Management Systems Engineering (MgtSE), a graduate option in Industrial & Systems Engineering at Virginia Tech, is concerned with the design of group and organizational systems, structures, and processes, using the engineering approach. The focus is on systems comprised of decision-makers, decision tools, and work processes, with an emphasis on the interactions among these components. MgtSE draws upon the following disciplines: engineering management, organization theory, quality management, macroergonomics, and information technology. The MgtSE option is designed to provide students with the knowledge and skills to meet the challenges posed by an increasingly complex, dynamic, and global environment (VT-ISE homepage, 1997)
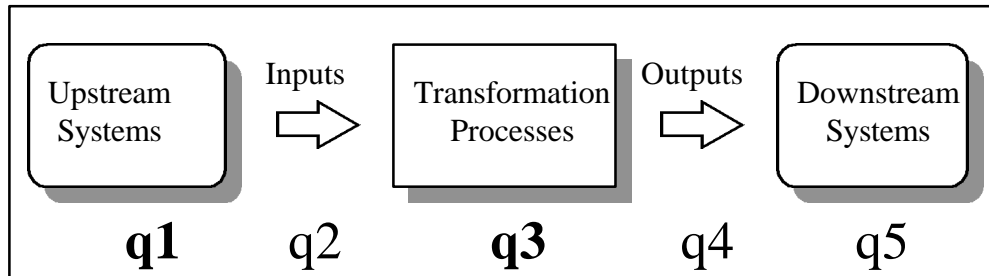
Figure 1-1. Organizational Systems
(Source: Sink, 1989)

Table 1-1. Definitions of Quality Checkpoints
(Source: Sink, 1989)

Quality checkpoint #1 (q1): Selection and management of internal and/or external upstream systems from which organizations receive inputs.
Quality checkpoint #2 (q2): In-coming quality assurance – the assurance that the organization is getting what it wanted, needed, expected, requested on time and within specifications.
Quality checkpoint #3 (q3): In-process quality management and assurance looks at the key transformation process (value-adding process) to check effectiveness, efficiency, and quality built into the products and services.
Quality checkpoint #4 (q4): Out-going quality assurance – the assurance that the organizational system is producing the desired goods and/or services on time and within specifications.
Quality checkpoint #5 (q5): The proactive assurance that the organizational system is meeting or exceeding customers' needs, specifications, requirements, wants, desires, and expectations.

tools and joint practices that will improve the effectiveness of q1-q3 relationships, whereas the marketing and purchasing definitions of upstream management focus on the q1-q3 relationship itself and the specific area of how to effectively use the purchasing function respectively. This distinction with regard to upstream management also illustrates one of the distinguishing features of MgtSE – *design*. These three perspectives each provide a different focus in performing specific upstream management tasks. This research adopts the design perspective of MgtSE, and focuses on tools and joint practices

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used in q1-q3[8] joint action and the shared results of q1-q3 partnerships.

1.2.2 Factors contributing to q1-q3 partnerships

Increasing international competition in many industries has required U.S. manufacturers to undertake strategic realignments of various kinds between q1 and q3 organizations (Lyons, Krachenberg, & Henke, 1990). One of the most noticeable changes has been in the relationship between q1 and q3 organizations, where managers of each organization have frequently made deliberate efforts to establish strong relationships with managers of another party (Heide & Stump, 1995). The nature of q1-q3 relationships has undergone significant changes during the last few years (Heide & John, 1990). Many industry observers and quality experts describe these relationships as becoming closer (Business Week, 1987). Terms such as partnerships (Ellram, 1991; Hendrick & Ellram, 1993; Johnson & Lawrence, 1988; Stuart & Mueller, 1994) and alliances (Bleeke & Ernst, 1995; Day, 1995; Lamming, 1993; Spekman, 1988; Varadarajan & Cunningham, 1995) are being used to differentiate these relationships from the more traditional arm's length, transaction-oriented relationships.

What is meant by a q1-q3 partnership and how is it operationally defined? One of the origins of the word partnership can be traced to Williamson's Transaction Cost Analysis (TCA[9]: 1979, 1985) in the marketing area, which consists of a blend of economics and organizational theory. The TCA's primary concern is with the issue of

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[8] For example, Pang (1990) conducted an MgtSE research study to identify tools and practices (interventions) used for each quality checkpoint. For q1, the most frequently used interventions were (1) understanding the market, (2) deploying information from different functions into product designs, (3) working with suppliers as partners, (4) certifying suppliers, and (5) communicating requirements and expectations clearly with suppliers. For q5, the most frequently used interventions were (1) managing customer perception, (2) achieving customer satisfaction, and (3) going beyond customer satisfaction.

[9] TCA is a normative model, which implies firms following its prescriptions will perform better (in the sense of having lower transaction costs) than other firms. The theory proposes that performance will be enhanced when there is congruence (or a "match") between the governance structure employed and underlying dimensions of exchange. According to Williamson (1979, 1985), three dimensions (or attributes) of transactions potentially determine the most appropriate governance structure: (1) the degree to which transactions are supported by transaction-specific investment, (2) the frequency with which transactions recur, and (3) the uncertainty surrounding the exchange (Noordewier, John, & Nevin, 1990).

crafting efficient governance structure, such as partnerships, strategic alliances, and closer relationships.

In this section, major factors that directly or indirectly contribute to forming q1-q3 partnerships are identified and briefly explained. Many factors contributing to q1-q3 partnerships are found in TQM and marketing areas. Researchers and practitioners in these areas have tried to identify and define the component variables that explain the nature of q1-q3 partnerships. Some examples from recent studies to operationally define the q1-q3 partnerships are commitment, trust, cooperation, mutual goals, performance satisfaction, adaptation, nonretrievable investments, and structural and social bonds (Wilson, 1995). This list is not exhaustive; many more factors could be added by other researchers to reflect situational uniqueness. Among factors identified by researchers, five of them – commitment to long-term relationship, specific investment, trust, two-way communication, and joint action – have been used most frequently to explain changing q1-q3 partnerships in terms of their importance in and contribution to the accomplishment of the goals and objectives of the relationship (Boyle et al., 1992; Ganesan, 1994; Heide & John, 1990 and 1992; Kaufmann & Dant, 1992; Kaufmann & Stern, 1988 and 1992). These five factors are described in the following sections.

1.2.2.1 Commitment to long-term relationships

Commitment to long-term relationships, also called continuity expectations, is defined as "the perception of the bilateral expectation of future interaction" (Heide & John, 1990, p. 25). This definition involves an anticipated duration into the future, rather than the historical duration to date. It is one of the most common contributing factors used in q1-q3 partnership studies. It implies the importance of the relationship to the partner and a desire to maintain the relationship into the future. Hardwick and Ford (1986) point out that commitment to long-term relationships assumes that the relationships will bring future value or benefits to both partners.

1.2.2.2 Specific investments

Specific investments, or non-retrievable investments, are defined as "the relationship-specific commitment or resources that a partner invests in the relationship" (Wilson, 1995, p. 338) and "that are of considerably less value outside the focal relationship" (Heide & John, 1990). In other words, the specific investments, such as capital improvements, training and education, and equipment, are not expected to be recovered if the relationship deteriorates or terminates. (It is also called forgo-opportunity cost or sunk cost.) Naturally, the two parties need to safeguard their investments from the possibility of relationship deterioration or termination. In other words, q1 and q3 organizations can take advantage of their specific investments by maintaining long-term relationships, not by incurring the switching costs when changing partners.

From the q1 organization's view, the specific investment can be a safeguard to remain the trusted supplier to its customer without the fear of being cut from the customer's preferred supplier list. From the q3 organization's view, the specific investment can produce at least one good result: supplier certification. Because the specific investment made by the customer leaves the company somewhat exposed to opportunistic behavior, it has an incentive to verify the capabilities of the supplier before establishing a relationship.

1.2.2.3 Trust

Trust is defined as "the willingness to rely on the partner in whom one has confidence" (Moorman, Zaltman & Deshpande, 1992, p. 315). It is also defined as "one party's belief that its needs will be fulfilled in the future by actions undertaken by the other party" (Anderson & Weitz, 1989, p. 312). An important aspect of these definitions is the notion of trust as a belief, sentiment, or expectation about the partner that results from the partner's expertise, reliability, and high intention of doing good for the other side. Trust based on a partner's expertise and reliability focuses on the objective competence and benevolence of an exchange partner, an expectancy held by one side that the partner's

promise can be relied on. This dimension encompasses consistency, stability, and control over the pattern of behavior exhibited.

In the context of this study, one party's trust in the other affects the long-term orientation of the partner in two ways: (1) it reduces the perception of risk associated with opportunistic behaviors by the other side and (2) it increases the partner's confidence in the other party that short-term inequities will be resolved over a long period. When trust exists, q1 and q3 organizations believe long-term investments can be made with limited risk because both parties will refrain from using their power to renege on business transactions or use a shift in circumstances to obtain profits in their favor. The mutual trust between q1-q3 relationships reduces the risk of opportunistic behaviors by the partner and increases the likelihood of a long-term orientation toward each other.

1.2.2.4 Two-way communication

Two-way communication is defined as "the exchange of information concerning plans, programs, expectations, goal setting, and performance evaluation that are critical for resolving disputes and coordinating actions" (Heide & John, 1990, p. 26). Typically, communication between q1 and q3 organizations would consist of product specification, delivery schedules, and the like. However, as the two parties more actively engage in two-way communication, other types of information begin to be communicated, such as long-term forecasting; proprietary and structured planning information, including future product design information; and a product planning schedule (Heide & John, 1990). Therefore, intensive communication should lead to better informed parties, which in turn should make each party more confident in the relationship and more willing to maintain it (Anderson & Weitz, 1989).

1.2.2.5 Joint Action

Joint action is defined as "the inter-penetration of organizational boundaries" (Guetzkow, 1966, p. 13) between q1 and q3 organizations to accomplish the goals and

objectives of both organizations. In traditional q1-q3 relationships, the responsibility for a given task is assigned to either the q1 or q3 organization. On the other hand, a move toward a partnership involves two parties carrying out the focal activities in a cooperative or coordinated way.

For example, with the technical development for components or parts in automobile industries, some suppliers are willing to take the responsibility for designing and developing new parts and components for their customers (Monden, 1983). This kind of q1-q3 joint action cannot be possible unless the two parties are ready to share their resources and talents in a cooperative and strategic way; the customer invests money in updating the supplier's equipment and training employees, while the supplier uses its technical talents and resources to develop competitive products for its customers and itself. Another example can be found in many practices of exchanging strategic data/ information between q1 and q3 organizations. The supplier's cost structure and the customer's detailed price information were seriously considered the most important business secrets that should not to be shared with its partners. However, sharing each party's strategic business data/information has become one of the common practices found in many q1-q3 partnerships (Lamming, 1993).

1.3   The Research Focuses on Joint Action

In summary, partnerships fundamentally possess the features of ongoing mutual inter-dependence and trust, a condition in which one party is vulnerable to another whose behavior is not under the control of the first. What is implied in the definitions and examples mentioned earlier is that a q1-q3 partnership and joint action may not be possible unless the relationship is established in a favorable business environment with commitment to a long-term relationship, relationship-specific investments, trust, and two-way communication.

An investigation of the relationships among the five factors described earlier falls more within the domain of marketing-relationalism than industrial engineering. This is because the relationship itself has been the major focus of research in relationalism,

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whereas research in industrial engineering has paid attention to specific joint action and performance improvement. Therefore, rather than modeling the five factors identified, this study will focus on one of the five: q1-q3 joint action. A primary reason for this purposeful focus on joint action is that an attempt to model the five factors depends on specific situations or factors that govern two organizations' relationships. In addition, it has been empirically shown that joint action is the desired outcome from many other factors including the four described in Sections 1.2.2.1 through 1.2.2.4 (Heide & John, 1990). (For a further explanation of this focus on q1-q3 joint action, see Section 1.15: Premises and Delimitations.) In summary, this study focuses on (1) joint action used in q1-q3 partnerships and (2) the relationship between joint action and shared results.

1.4   *Problem Statement*

Much literature and research on organizational transformation processes has dealt with theories and practices that include brief introductions to upstream management. This literature, however, does not identify the specific tools and joint practices that organizations use to develop world-class q1-q3 relationships. Leading edge q1-q3 partnerships are found only in many quality experts' theoretical assertions and a few internationally well-known companies. Except for a few organizations, such as Ford, GM, and Xerox, that are well-known and recognized for upstream system management and have won nationally renowned awards, e.g., the Malcolm Baldrige National Quality Award, there is little research on the systematic and specific approaches used by many organizations to improve q1-q3 relationships. There is apparently no empirical research on the content of q1-q3 joint action (tools and joint practices) or the outcomes (shared results). The anecdotal case studies are of little help as there is little or no arguments about the definitions of terms such as closeness and partnership. This is because they do not provide evidence that can be generalizable to other q1-q3 relationships.

Upstream management, especially q1-q3 partnerships, cannot be operationally defined only by exemplary cases. The definition should include detailed and planned analysis and evaluation of what q1 and q3 organizations are doing to increase joint action

and to share the results of joint action to accomplish organizational objectives. Without operationally defining upstream management and analyzing those joint practices and shared results, it is difficult for managers of q1 and q3 organizations to succeed in internal/external and domestic/international competition.

Some researchers and practitioners have been addressing q1-q3 partnerships and joint action. Some examples are Chen & Batson (1996), Stuart & Mueller (1994), Morgan & Zimmerman (1990), and Johnson (1989). These studies were aimed at encouraging q1 and q3 managers to use more joint action by identifying specific performance improvement results, such as improved quality and productivity, reduced production cost and delivery lead-time, closer and more cooperative relationships. However, some important points not adequately addressed by these studies are:

- a description of tools or joint practices used by q1 and q3 organizations as a means to increase q1-q3 joint action;

- an investigation of the level of effectiveness and internalization of tools or joint practices used; and

- an investigation of the relationship between tools and joint practices and their effectiveness in terms of the four shared results – role integrity, conflict resolution, flexibility, and mutuality.

1.5   *Global Research Model*

This study on q1-q3 partnerships can be seen as one intervention used to improve organizational performance within a Total Quality Management (TQM[10]) perspective. This point is depicted in the global research model in Figure 1-2. According to TQM authorities (Deming, Juran, and Ishikawa), organizations should implement the five prescribed interventions summarized by Hackman & Wageman (1995) – (1) creation of supplier partnerships, (2) identification and measurement of customer requirements, (3)

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[10] TQM is a systematic approach to the practice of management, requiring changes in organizational processes, strategic priorities, individual beliefs, individuals attitudes, and individual behaviors (Olian & Rynes, 1991, p. 304).

use of cross-functional teams to solve quality problems, (4) use of scientific methods to monitor performance and to identify points of high leverage for performance improvement, and (5) use of process-management heuristics to enhance team effectiveness. These five interventions are prescribed by quality experts as core factors contributing to organizational transformation within a TQM perspective. The creation of supplier partnerships is one of the five interventions. TQM authorities suggest that q3 organizations should choose suppliers on the basis of quality, rather than solely on price. Moreover, they recommend organizations work directly with suppliers to ensure their inputs are of the highest quality possible (Deming, 1986; Ishikawa, 1985; and Juran, 1981).
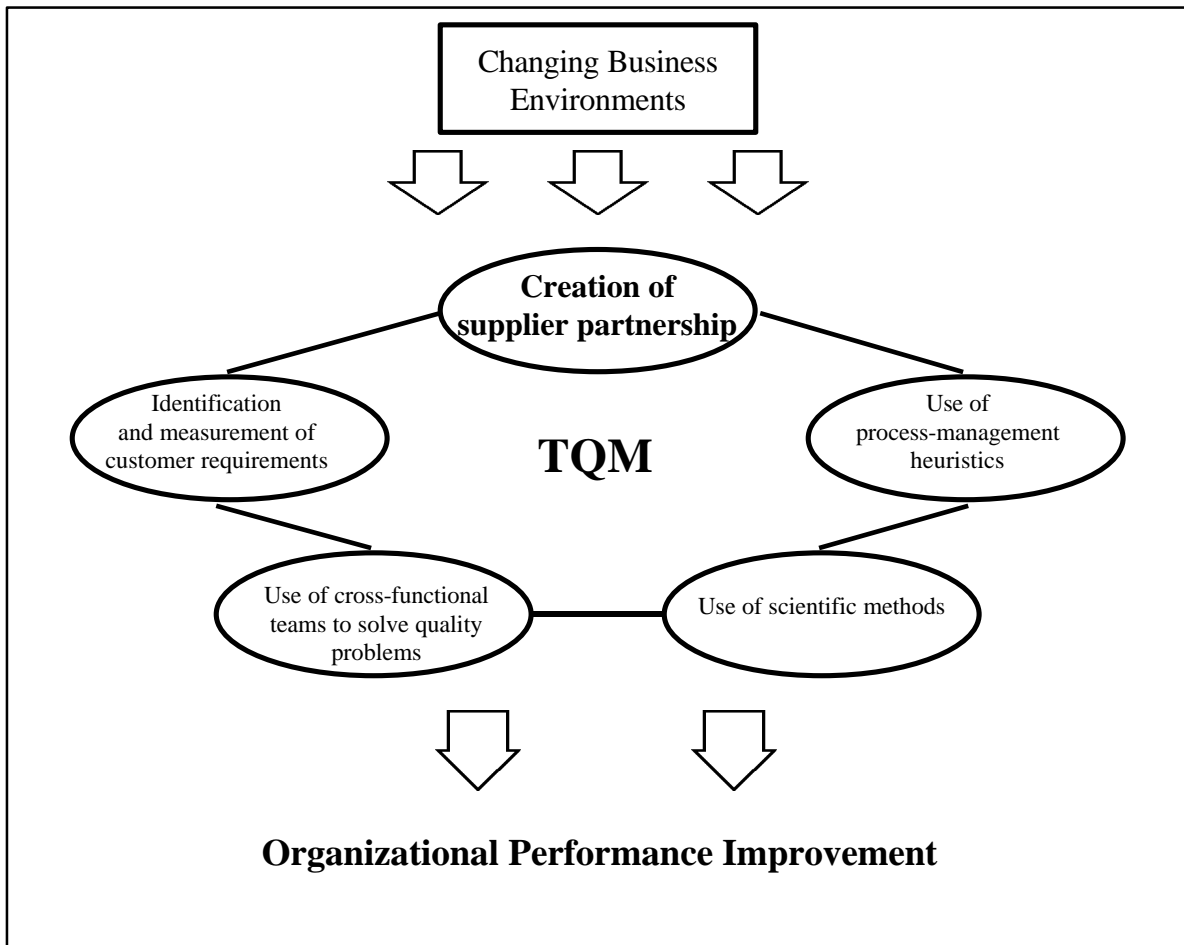
Figure 1-2. Supplier Partnership in the Context of Total Quality Management (Summarized from Hackman & Wageman, 1995)

As shown in Figure 1-2, a changing business environment drives organizations to adopt TQM interventions, including q1-q3 partnerships. Some examples of the changing business environment are global concept, increased expectation of quality from customers, and increased use of supplier certification that encourage organizations to create q1-q3 partnerships.

1.6   Conceptual Research Model

To examine q1-q3 partnerships more closely, two conceptual models for this research (Figures 1-3 and 1-4) illustrate the overall picture and scope of q1-q3 partnerships and the domain of this research. Figure 1-3 is an adapted portrayal of the Management Systems Model (MSM; Kurstedt, 1994), which describes the components
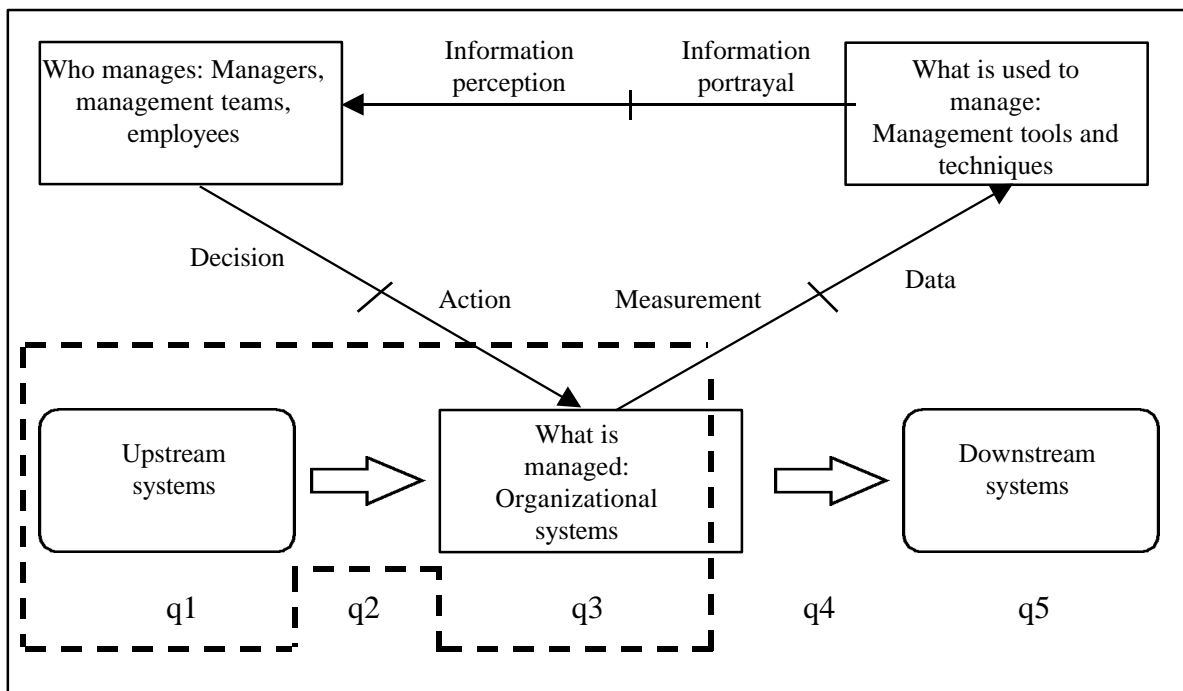
Figure 1-3. Management Systems Model
(Adapted from Kurstedt, 1994 and Sink, 1995)

and relationships in a management system and highlights the need for the balance obtained by matching the interfaces between pairs of components for the domain of responsibility to

perform well. In the context of q1-q3 partnerships, the MSM in Figure 1-3 can be interpreted as follows: influenced by information from internal/external business environments, such as competitive pressures, increased expectation of quality from customers, increased use of certification mechanisms to facilitate responding to the Malcolm Baldrige National Quality Award, International Standard Organization (ISO) 9000 Certification, and internal/external quality audits, and so on (*Information Portrayal),* managers, especially those in functions related to managing q1-q3 relationships, realize the need for significant changes in relationships with customers and suppliers (*Information Perception).* Based on this information portrayal-perception, managers make decisions on interventions for q1-q3 partnerships that include the effective use of tools and joint practices to improve organizational performance.

The domain of this research is portrayed within the dotted line in Figure 1-3. The focus on improving q1-q3 partnerships is depicted in the conceptual research model in Figure 1-4, using the two major variables (joint action and shared results) and other factors that contribute to joint action. In this study, these four factors are assumed to be pre-requisite conditions for q1-q3 joint action and are not included in the domain and focus of q1-q3 partnerships. Rather, this study focuses on the relationship between q1-q3 joint action (as an independent variable) and shared results (as a dependent variable) which are included in the solid line in Figure 1-4.

In addition, three specific organizational performance dimensions – quality, cost, and cycle time – are also used to measure perceived changes in organizational performance resulting from q1-q3 joint action and shared results. These three performance dimensions are selected in this research because they are the most frequently identified performance results of q1-q3 joint action in previous literature on various tools and joint practices. (See Tables 2-6 and 2-8 for more information about these three performance dimensions and other specific performance dimensions used to assess the impact of q1-q3 joint action.) Therefore, instead of using different organizational performance dimensions that are situation-specific, three of the most widely-used

dimensions are studied in this research. It should be also noted that although measuring the perceived changes in organizational performance using the three dimensions is included in the domain of this research (solid line in Figure 1-4), it is exploratory work based only on managers' perceptions.
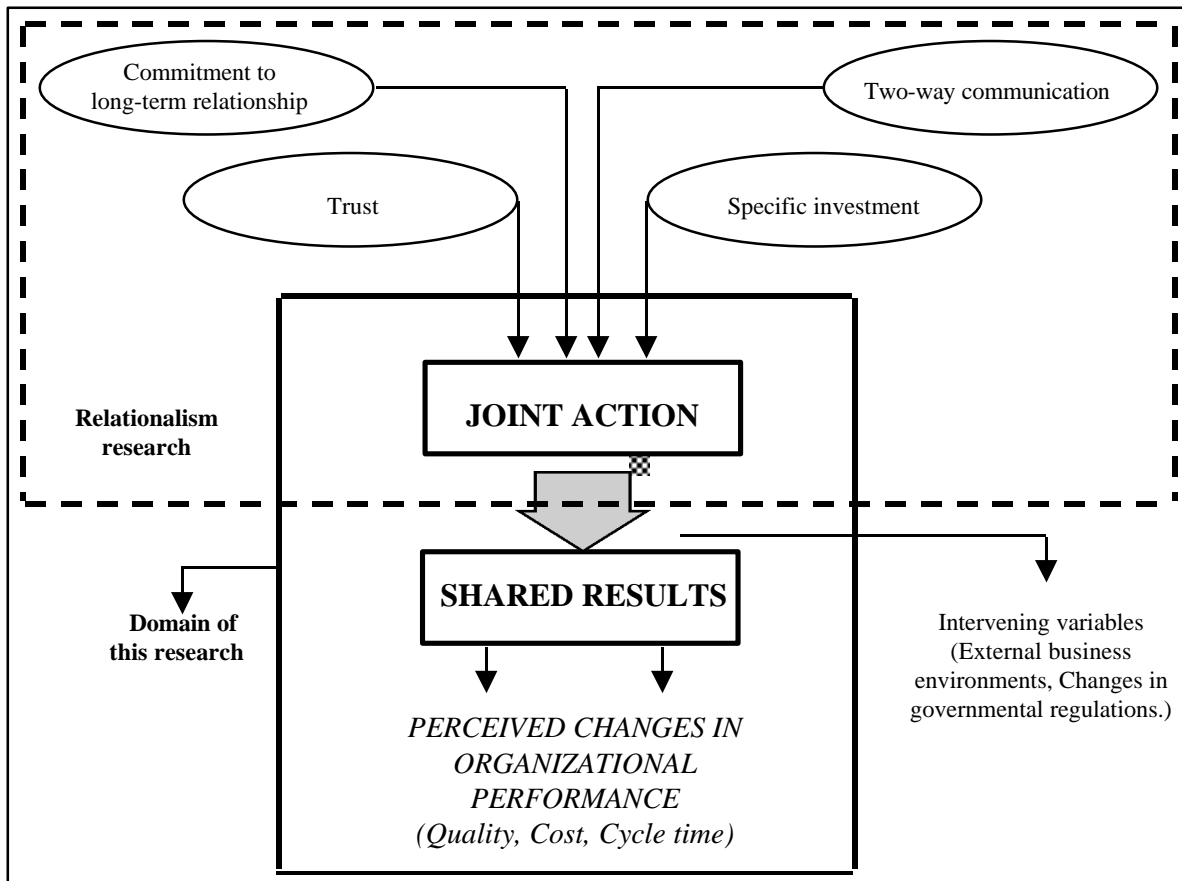
Figure 1-4. Conceptual Research Model

1.7   *Operational Research Model*

The operational research model in Figure 1-5 shows research questions, independent/dependent variables, and their hypothesized relationships, which are explained in-depth in Sections 1.10, 1.11, and 1.12, respectively.

By focusing on the shared results of q1-q3 joint action, this research examines the level of four shared results – role integrity, conflict resolution, flexibility, and mutuality –

that have been accomplished in varying degrees from one q1-q3 relationship to another. This is done by a mailed survey questionnaire. The survey produced the quantitative data used to test hypotheses from which findings about the accomplishments of the four shared results can be derived in statistically general terms.

The problem statement, the global research model, two conceptual research models, and the depicted relationship between joint action and shared results lead to the research purpose and specific research objectives in the following sections.
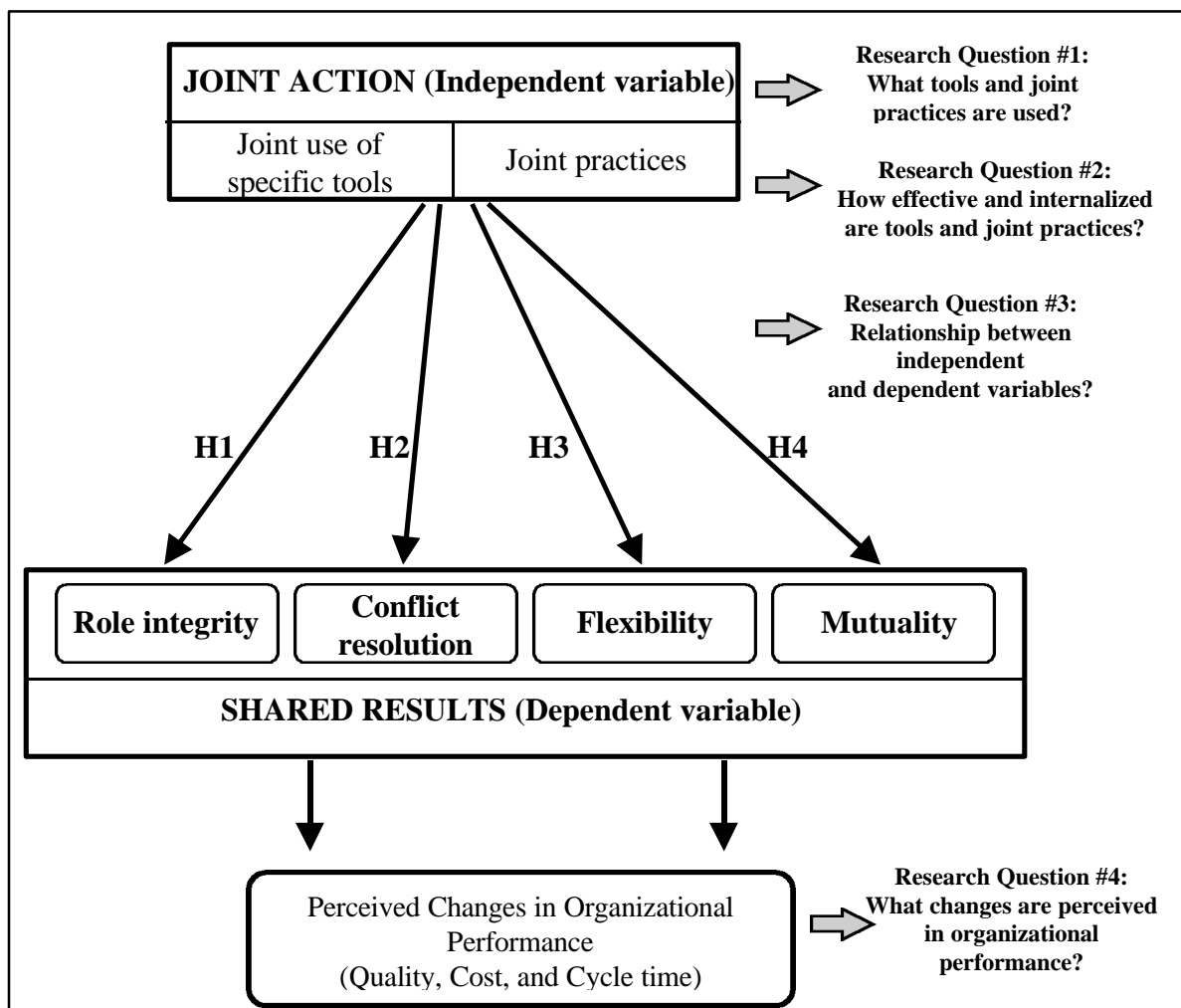
Figure 1-5. Operational Research Model

1.8   Research Purpose

The overall purpose of this research is to study q1-q3 relationships, in particular q1-q3 partnerships, to extend the body of knowledge on organizational upstream systems. To accomplish this purpose, the following research objectives will be achieved.

1.9   Research Objectives

#1:   to describe specific tools and joint practices (joint action) used in q1-q3 partnerships;

#2:   to identify tools and joint practices that are perceived more effective and internalized than others;

#3:   to investigate the relationship between q1-q3 joint action and shared results; and

#4:   to examine perceived changes in specific performance dimensions (quality, cost, and cycle time) resulting from q1-q3 joint action and shared results.

First, identifying the most frequently used tools and joint practices in U.S. private manufacturing companies will provide people in the same or similar industries with guidelines on which tools and joint practices they can use to manage and improve their q1-q3 relationships. Second, examining the level of effectiveness and internalization of tools and joint practices identified will benefit practitioners and experts by differentiating the tools and joint practices that have been more effective and internalized from others, which will also provide guidelines on which tools and joint practices should be used to improve the effectiveness of q1-q3 relationships. Third, investigating the relationship between q1-q3 joint action and shared results will justify how much impact q1-q3 joint action has on four dimensions of the shared results. The relationship between q1-q3 joint action and shared results will show practitioners when they should use more *or* less joint action to better manage the shared results of joint action. And fourth, measuring perceived changes in three organizational performance dimensions (quality, cost, and cycle time) will identify differences, if any, between objective organizational performance measures (from previous literature) and perceived organizational performance measures (from this research).

The aim in achieving these objectives is to help managers/practitioners of q1 and q3 organizations successfully design, develop, implement and deploy tools and joint

practices based on the findings of this research. Specifically, for those organizations that have been successful in upstream management practices, this research will provide additional opportunities to re-evaluate the effectiveness of their upstream systems in order to further advance towards becoming world-class organizations. This can be done by filling the gap, if any, between the theoretically ideal q1-q3 relationships found in many quality experts' theories and practitioners' assertions and their current upstream system practices. Additionally, for other organizations not successful in their upstream management practices or that have not used tools and joint practices, this research will describe what tools and joint practices are used and the outcomes (shared results) of using them.

1.10   Research Questions

To achieve the purpose and objectives identified, the following questions will be addressed.

#1:   What tools and joint practices have been used by U.S. private manufacturing companies in q1-q3 joint action?

#2:   Which tools and joint practices have been more effective and internalized in q1-q3 joint action?

#3:   What is the relationship between tools and joint practices and the shared results perceived by customers and suppliers?

#4:   What changes (increase or decrease) in organizational performance dimensions (quality, cost, and cycle time) are perceived as a result of q1-q3 joint action and the shared results?

1.11   Independent and Dependent Variables

As explained previously, q1-q3 joint action is treated as the independent variable in this non-experimental research study, while the four shared result measures are treated as dependent variables. The three performance measures shown in Figure 1-4 – quality, cost,

and cycle time – are considered specific outcomes of shared results that are, in turn, dependent on q1-q3 joint action.

1.11.1 Independent variable

The q1-q3 joint action has been one of the foci of relationalism research. Some researchers (Heide & John, 1990; Lamming, 1993) have considered q1-q3 joint action as the desired outcome of q1-q3 partnerships that greatly influence the performance of q1 and q3 organizations. To improve, or at least to influence positively the two organizations' performance, q1-q3 joint action should be based on organizations' commitment to long-term relationships, mutual trust, effective communication, and specific investment.

In this research, q1-q3 joint action is assessed via two indicators: (1) joint use of specific tools and (2) joint practices. The q1-q3 joint action characterized by using specific tools is defined as the use of pre-determined or suggested steps or procedures to implement a given tool. Examples can be joint use of tools such as Quality Function Deployment (QFD) to design and develop new parts or products to meet the needs/wants of the final customer or Just-In-Time (JIT) delivery systems to streamline the flow of parts and components. In using these tools, q1 and q3 organizations may not need to develop new mechanisms to implement and deploy them. This is because researchers and practitioners have already developed mechanisms and steps or procedures that have been widely adopted. However, organizations may need to revise the existing operating procedures of the tools and joint practices to increase the effectiveness of the tools.

On the other hand, the q1-q3 joint action categorized by joint practices refers to activities characterized by personal contacts rather than by using specific tools. Examples are meetings between q1 and q3 personnel for joint planning and problem-solving or an exchange of strategic information. These practices do not involve specific tools. In other words, joint practices can include frequent and intensive personal contacts to plan and improve q1-q3 performance objectives.

1.11.2 Dependent variables

Most joint activities used in q1-q3 partnerships require and encourage q1 and q3 organizations to share the results of their joint action. However, the results of joint action may be anything from deteriorated q1-q3 relationships to an ideal situation where future joint practices can be implemented and deployed in a more aligned environment.

The four shared results dimensions introduced earlier – role integrity, conflict resolution, flexibility, and mutuality – are used in this study to examine the broader scope of the results of q1-q3 joint action. As explained in greater depth in the following section (Hypotheses), these four shared results dimensions indirectly encompass specific performance measures, as well as behavioral measures. For example, the two shared results dimensions – role integrity and mutuality – closely relate to specific and monetary performance measures such as investments and sharing of benefits and expenses, whereas the other two shared results dimensions – conflict resolution and flexibility – focus on behavioral measures such as a willingness to resolve problems informally and a capability of being flexible in changing business/operating environments.

Each of the four shared results dimensions has been studied by many researchers in relationalism as a dependent variable of either one or a combination of the critical factors of relationalism research – commitment to long-term relationship, trust, two-way communication, and specific investment. Some examples of previous relationalism research that deal with each one or a combination of the four dimensions are: role integrity by Dant and Schul (1992), Kaufmann and Dant (1992), and Kaufmann and Stern (1988, 1992); conflict resolution by Kaufmann and Dant (1992); flexibility by Boyle et al. (1992), Heide and John (1992), and Noordewier, John, and Nevin (1990); and mutuality by Boyle et al. (1992), Dant and Schul (1992) and Noordewier, John, and Nevin (1990). However, no study has attempted to address all four dimensions as a set of dependent variables of q1-q3 joint action in an integrated way. Additionally, no study has used the term *shared results* to refer to all four dimensions together.

Among these four shared results dimensions, role integrity and mutuality are further divided into two categories: role integrity and mutuality, each *with* and *without* financial impact. Unlike the other two dimensions (conflict resolution and flexibility) that are characterized by more behavioral or attitudinal aspects than financial impacts, role integrity and mutuality are characterized by operations and transactions that sometimes involve financial impacts on two organizations. For example, some form of q1-q3 joint planning may result in a specific investment from the supplier, such as tooling, equipment, and training employees (role integrity with financial impact), while regular meetings between the two parties can provide each with long-range forecasts of supply or demand requirements (role integrity without financial impact). However, all the operations and transactions used to increase the degree of role integrity and mutuality may not always have financial impacts on the two organizations' performance. Therefore, the two sub-dimensions – *with* and *without* financial impacts – have been chosen to differentiate the former sub-dimension from the latter.

In addition to the independent and dependent variables, three performance dimensions that are perceived by managers are used to measure the impact of q1-q3 joint action and shared results. In this research, each of the three dimensions includes at least one sub-dimension, as described below, to measure the impact of q1-q3 joint action and shared results (sub-dimensions identified below are selected as specific performance results in previous literature on various tools and joint practices; see Tables 2-6 and 2-8):

- Quality: supplier's defect rate, quality of final products, quality of q1's service quality of incoming purchased items;
- Cost: supplier's and customer's total cost, changes in product price; and
- Cycle time: time between order and delivery.

1.12   *Hypotheses*

An investigation into the relationship between shared results and q1-q3 joint action, specifically the relationship between the joint action measures and each shared

results dimension, will be done by testing hypotheses about each specific relationship. The hypotheses are described in the next sections.

1.12.1 Role integrity

Roles in the q1-q3 relationship have intricate interlinkings of habits, custom, internal principles and rules, social relationships, and expectations about the future. In other words, role integrity is the extent to which parties maintain highly complex and multi-dimensional roles. Moreover, as joint action develops, roles grow in duration, the extent of specific transactions, and the range of obligations. In such circumstances, role integrity is more than simply maintaining the responsibilities of each party (MacNeil, 1980).

In the context of q1-q3 partnerships, both parties enact roles that not only govern the individual joint activity, but also cover a multitude of issues not directly related to any single activity. The transition from the traditional arm's-length relationship to the partnership is characterized by a change from simple and unidimensional to highly complex roles (Kaufmann & Stern, 1988 and 1992). In their research on the role of dependence balancing between buyer and seller, Heide and John (1988) developed a theoretical extension to the basic transaction-oriented q1-q3 relationship by combining evidence of increased level of joint action with the traditional approach. Later, in their research (1990) on the determinants of joint action in buyer-seller relationships, they also identified major positive effects of joint action on the roles of buyer and seller, such as joint tool development and product design, design of quality control and delivery systems, and long-term planning.

For example, in the traditional short-term, arm's-length relationships, the supplier was supposed to meet the specifications provided by its customer. However, in today's q1-q3 partnerships, the supplier is expected, and sometimes required, to share the responsibility for designing and developing new parts and components that will be assembled by the customer and even sold under the customer's brand name. On the other hand, for the supplier to be involved in R & D activities early in the new product

development, the customer is obliged to invest its money in the supplier's facilities and equipment. This was not common before the advent of the q1-q3 partnership. The above argument and example can be summarized as the first hypothesis:

> **H1[11]: Organizations with higher levels of joint action have higher degrees of role integrity.**

Definition of Role Integrity: The extent to which parties maintain highly complex and multi-dimensional roles in terms of duration, extent of specific transaction, and range of obligations (Kaufmann & Dant, 1992).

1.12.2 Conflict resolution

In the traditional arm's-length and isolated operating environment, conflict resolution is a formal and external process. The formal and external process can be viewed as institutionalized in that it represents policies implemented by the q1 and q3 organizations to address conflict in a systematic and ongoing manner (Dant & Schul, 1992). However, in q1-q3 partnerships, conflict resolution tends to be informal and internal (Kaufmann & Dant, 1992). MacNeil (1980) indicates that the more relational an exchange becomes (in other words, the higher the level of joint action between q1 and q3), the more a separate and distinct (and also internal and informal) social order is created within the relationship itself. The informal and internal process is a mechanism consisting of activities or processes, rather than systematic policies that make conflict resolution more smooth and favorable to each party.

This informal and internal conflict resolution tends to be viewed and treated in a more routine business environment using specific problem-solving processes as one of the results of joint action. This is because joint action is likely to make the manager's decisions on conflict resolution more programmed and easier than when there was no joint

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[11] In analyzing data obtained from the survey, four sub-hypotheses will be tested to examine the relationships: joint use of specific tools-role integrity with financial impacts, joint practice-role integrity with financial impacts, joint use of specific tools-role integrity without financial impacts, and joint practice-role integrity without financial impacts.

action between q1 and q3 organizations. The argument in this section can be summarized as the second hypothesis:

> **H2[12]: Organizations with higher levels of joint action resolve conflicts less formally.**

> Definition of Conflict Resolution: Internal and informal mechanisms (procedures/ processes/activities) to resolve any problems that arise in the transactional and relational exchanges between the two organizations smoothly and more favorably to each other.

1.12.3 Flexibility

If change is to occur in the operations between two parties so that they conform to changes in the environment, it must either be envisioned and permitted within the existing relationship, or it must be possible for the existing operational specifications to be modified in an appropriately negotiated way. Flexibility involves smooth alterations in practices and policies by understanding each other's operations in the light of unforeseen or changing conditions (Boyle et al., 1992). In q1-q3 partnerships, two organizations have open-ended attitudes in terms of requiring and accepting changes in their operations. This is because flexibility defines a bilateral expectation of willingness to make adaptations as operating environments change. Noordewier et al. (1990) defines supplier flexibility as the one displayed by suppliers toward buyer-requested adjustments to the extant relationship. Buyer's requests for adjustments constitute opportunities for a supplier to display flexibility.

For example, in coping with market price changes under q1-q3 partnerships, joint effort towards cost reduction forms a key part of information exchange: there is a combination of working pressure and cooperation, coupled with transparency in costing (i.e., both partners are aware of the relevant parts of the cost structure of each other's process and the implications for changes in the other). In this situation, the two parties are

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[12] In analyzing data obtained from the survey, two sub-hypotheses will be tested to examine the relationships: joint use of specific tools-conflict resolution and joint practice-conflict resolution.

willing to accept the given conditions and problems. Thus, for example, as material supply or economic pressures force cost increases on the supplier, it is the joint responsibility of the partners to find ways to counteract the problem. The argument and example in this section can be summarized as the third hypothesis:

H3[13]: Organizations with higher levels of joint action have higher degrees of flexibility.

Definition of Flexibility: A bilateral expectation of willingness to make adaptations as operating environments change (Heide & John, 1992).

1.12.4 Mutuality

Mutuality implies the requirement of a positive incentive to cooperate with the partner. Under the traditional arm's-length and isolated operating environment, each party requires positive outcomes from each discrete transaction and envisions monitoring each transaction as if it were the last and only mechanism capable of delivering the desired outcomes. However, in a q1-q3 partnership, two parties expect generalized reciprocity emanating from their ongoing and indeterminate relationships (Kaufmann & Dant, 1992). Mutuality also refers to equity in the distribution of surpluses (or benefits) and burdens over the course of the business transaction. Because benefits and deficits accrue somewhat unpredictably in the course of business relationships, the two parties need general principles for sharing them. Under a high level of mutuality, benefits are evaluated over a long period of time rather than on a transaction-by-transaction basis (Boyle et al., 1992).

In the case of the Japanese keiretsu-type of q1-q3 relationship, the supplier is sometimes required to take the risk of losing short-term profits in order to lower the price of the final product. This makes its customer more competitive in the market. This risk-sharing and loss of short-term profits is possible only when the q1-q3 partnership

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[13] In analyzing data obtained from the survey, two sub-hypotheses will be tested to examine the relationships: joint use of specific tools-flexibility and joint practice-flexibility.

guarantees the supplier its share in the future in the relationship with its customer. Dyer and Ouchi (1993) examined Japanese-style partnerships characterized by a more cooperative relationship with the other party. They identified cost savings resulting from more joint action between the two parties and also pointed out the competitive advantages the two firms realized by equal distribution of cost savings over the long-term. Thus the argument and example can be summarized as the fourth hypothesis:

H4[14]: Organizations with higher levels of joint action have higher degrees of mutuality.

Definition of Mutuality: In relational terms, mutuality refers to a requirement of a positive incentive to cooperate with the partner. It also refers to equity in the distribution of surpluses and burdens (or benefits and expenses) over the long-term business transactional horizon.

1.13   *Research Variables, Questions, Hypotheses, and Data Sources*

Table 1-2 summarizes key information in this chapter so far along with data sources for each question. It should be noted that actual hypotheses tested differ from those defined in this chapter, based on results from reliability analysis and factor analysis (described in Chapter 3).

1.14   *Contribution of This Research*

This research is the first attempt of which the researcher is aware to explore the shared results of the joint action between q1 and q3 organizations to build/expand theories in upstream management systems (q1) in conjunction with the organizational transformation processes (q3) and marketing-relationalism theory. In other words, this research focuses on the shared results of q1-q3 joint action that are based on partnerships.

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[14] In analyzing data obtained from the survey, four sub-hypotheses will be tested to examine the relationships: joint use of specific tools-mutuality with financial impacts, joint practice-mutuality with financial impacts, joint use of specific tools-mutuality without financial impacts, and joint practice-mutuality without financial impacts.

There are two reasons this research focuses on the shared results of q1-q3 joint action rather than on the key factors of q1-q3 partnership (commitment to long-term relationship, trust, two-way communication, and specific investment).

Table 1-2. The Relationship among Research Questions, Hypotheses, Key Variables, and Data Sources

Variables[*]	Research Questions	Research Hypotheses[**]	Data Sources[***]
Independent variable: q1-q3 joint action using tools and joint practices	**Q1**: What tools and joint practices?		Mailed survey questionnaire and structured interview
	Q2: Effectiveness and internalization of tools and joint practices?		Mailed survey questionnaire
Dependent variables: Shared results (role integrity, conflict resolution, flexibility, and mutuality)	**Q3**: How is joint action related to shared results? (The relationship between independent and dependent variables)	**H1**: q1-q3 joint action and role integrity **H2**: q1-q3 joint action and conflict resolution **H3**: q1-q3 joint action and flexibility **H4**: q1-q3 joint action and mutuality[****]	Mailed survey questionnaire
Performance outcome variables (quality, cost, and cycle time)	**Q4**: What changes in organizational performance are perceived in three specific performance outcomes?		Mailed survey questionnaire

*: Intervening variables, such as external business environment and changes in government regulations, are not addressed in this research.
**: Actual hypotheses tested (in Chapter 4. Results) were revised based on results of reliability analysis and factor analysis described in Chapter 3.
***: Major data source to address each research question is ordered first.
****: Actual hypotheses tested are revised from those shown here, as described in Chapter 3 (Figure 3-4), to reflect changes to dependent variables from reliability analysis and factor analysis.

First, regarding the five key factors of q1-q3 relationships and their potential/possible relationships, many researchers and practitioners in marketing and purchasing or materials management have already done a significant amount of research in the name of relationalism or relational theory, and have produced a theoretical background. Consequently, the most recent achievements in relationalism reflect only the

situational factors that may differentiate one q1-q3 situation from another. Naturally, this phenomenon leads to the selection of the five most used factors of q1-q3 partnerships.

Second, regarding the categorized shared results of q1-q3 joint action, there has been some research on specific cases of the shared results of q1-q3 joint action. For example, Stuart and Mueller (1994) have examined the differences of productivity performance between partnership-type q1-q3 relationships and non-partnership-type q1-q3 relationships. Even though their research produced a clear-cut distinction between partnership-type relationships and non-partnership-type relationships in terms of improved productivity, this kind of research and its outputs are not sufficient to build new theoretical assertions on the shared results of q1-q3 joint action in broader terms that address both specific performance and behavioral measures. This is why many small, potential performance measures are categorized into the four shared results. Even though these four categorized dimensions of shared results cannot address the consequences of every q1-q3 relationship because of specific situational factors, the results produced in this research will either build new or expand old theories in more general terms.

Another contribution from the Industrial & Systems Engineering-Management System Engineering perspective is the focus on tools and joint practices that are intended to produce the desired level of partnerships and shared results. By focusing on the relationship between tools and joint practices used by q1 and q3 organizations and shared results, this research investigates the role of tools and joint practices in terms of their contribution to results-sharing practices between q1 and q3 organizations.

1.15 *Premises and Delimitations*

Premises are propositions offered as fact or as prior suppositions that are given in a logical argument. In other words, premises are used to define, support, or put boundaries around the statements used as propositions. Delimitations identify what the problem is not. Typically, delimitations are thought of as limits imposed on the study to identify the problems that are not solved.

1.15.1 Premises

The first premise is that there is little empirical research that has addressed tools and joint practices in relation to the four shared results of q1 and q3 organizations' joint action. There have been many researchers who have examined the effects of certain tools on specific performance dimension(s). However, they have not addressed the four proposed results of the tools in an integrated way. This research does that.

The second premise relates to how the five key factors for q1-q3 partnership – trust, commitment to long-term relationship, communication, specific investment, and joint action – are treated. Rather than making assumptions about the relationships among the proposed five factors, it is reasonable to view the first four factors as pre-requisites of the last, joint action. This is because joint action has been an outcome of other factors in many studies on q1-q3 partnerships (Black, 1984; Bonoma, 1976; Heide & John, 1990).

1.15.2 Delimitations

The first delimitation is the source of research data. In this research, only manufacturing companies, not service industries, are considered as the source of data for the mailed survey questionnaire and structured interviews. There are limitations in using service industries: (1) two related characteristics of service industries are intangibility and perishability, which means services cannot be seen, felt, etc., in the same way tangible products can be used; (2) two other unique attributes are heterogeneity and inseparability of production and consumption, which means that these two attributes entail the inability of a producer to provide consistent service performance and quality. Unlike tangible products, services are sold, then produced and consumed simultaneously. These reasons are likely to make it difficult for managers of q1 and q3 organizations to accurately assess the performance of the use of certain tools and joint practices when answering the mailed and interview questions.

The second delimitation is how manufacturing companies (and managers) are selected. For the mailed survey questionnaire, [1] an equal number (333) of managers of (1) purchasing, (2) sales/marketing, and (3) operations/production (from an industry

directory – *Directory of Corporate Affiliations* [1996]) and [2] 812 members of American Society for Quality Customer-Supplier Division (ASQ-CSD) are sampled. The sample size of 333 managers from the three groups and additional 812 ASQ-CSD members for a total of 1,811 is based on previous research in relationalism for which a 10-20% response rate was achieved (Boyle et al.,1992; Heide & John, 1990 and 1992; Kaufmann & Stern, 1992). To conduct the statistical analyses used in this research (Chapter 3), this research needed to have at least 1000 potential respondents so that findings could be generalized in a statistically meaningful way. In addition, a total of 1,811 sample size also meets two rules of thumb proposed by Thorndike (1978): (1) $N \geq 10(p+c) + 50$ and (2) $N = (p+c)^2 + 50$, where N is the minimum required sample size, p is the number of predictor (or independent) variables, and c is the number of criterion (or dependent) variables. In the case of this research, 130 and 114 are the minimum required sample sizes based on Thorndike's two proposed formulations (where p=6 and c=2). For the interviews, however, a number of sampled q1 and q3 managers are used to increase the consistency of qualitative data.

The third delimitation is the financial (or capital) structure of q1 and q3 organizations. For this research, the q1-q3 partnership, in which one party's administrative and financial structure has direct influence on the other party's operations, are not considered. If one party, q3 in most cases, has direct control over the partner's administrative and operating procedures because of financial dominance, it is likely that decisions made by the influenced company in relation to its partner's joint action are also controlled by the influencing partner. This type of relationship may provide biased research data on real partnership practices. For example, tools or other practices chosen by the influencing party may be used to improve goals and objectives of that party only. This does not comply with the definition of joint action introduced earlier where joint action is defined as the inter-penetration of organizational boundaries (Guetzkow, 1966; Laumann, Galaskiewicz, & Marsden, 1978) between q1 and q3 organizations to accomplish the goals and objectives of *both organizations*. A power-dominant

relationship may provide biased research data on the level of four dependent dimensions as well as tools or other joint practices.

The fourth delimitation is the use of a set of four dependent variables. Because the independent variable used in this research – q1-q3 joint action (joint use of specific tools and practices) – includes a broad range of tools and practices, it is difficult to select an universal set of objective measures as dependent variables. Attempting to select a set of objective performance measures as dependent variables could result in using only a few performance measures that can be applied to *some* tools and joint practices, not to q1-q3 joint action *in general*. This is why a set of four shared results dimensions – role integrity, conflict resolution, flexibility, and mutuality – is used to measure the degree of accomplishment of q1-q3 joint action.

1.16 *Organization of This Document*

The organization of this document is shown below.

Chapter 1	**Introduction**
⇓	- Problem statement - Research questions - Research purposes - Research hypotheses - Conceptual/operational research models and other research framework

⇓

Chapter 2	**Body of Knowledge Review**
⇓	- Organizational upstream system - q1-q3 joint action - q1-q3 partnership - Research methods/tools (survey/scale development, structured interview) - Exemplary upstream system management practices from the literature and indirect observation

⇓

Chapter 3	**Research Methodology**
⇓	- Definition of research methods - Identification of sources/collection methods of research data - Description of approaches to analyzing data

⇓

Chapter 4	**Results & Discussion**
⇓	- Portrayal of data and information derived from analyses Results for Research Question #1: Section 4.2 Results for Research Question #2: Section 4.3 Results for Research Question #3: Section 4.4 (Hypothesis testing) Results for Research Question #4: Section 4.5 Supplementary results: Section 4.6

⇓

Chapter 5	**Conclusions**
⇓	- Conclusions - Interpretations - Limitations of this research - Areas for future research

⇓

Chapter 6	**Practical Implications**
	- Practical implications from research findings

Figure 1-6. Organization of This Document.

CHAPTER 2. BODY OF KNOWLEDGE REVIEW

The purpose of this chapter is not only to serve as a product itself, but also as input to future chapters. This chapter first introduces experts' perspectives on key issues of upstream system management. Next, the specific research findings relevant to the operational research model in Figure 1-5, e.g., q1-q3 joint action and proposed shared results, are reviewed, followed by exemplary upstream management practices.

This chapter (Leedy, 1993):

- reviews the previous literature and research to reveal similar investigations, and demonstrates how other researchers have addressed these situations;

- reveals data sources used by other researchers;

- shows this research in a historical and associational perspective in relation to earlier attempts to address the same or similar problems; and

- helps evaluate this research's efforts by comparing them with similar efforts of others.

2.1   Review of Research on Upstream Management

This section describes quality experts' assertions on upstream management and also introduces changes in organizational supply management practices and purchasing development from historical perspectives.

2.1.1   Quality experts' key issues on upstream management

Besides clear distinctions among experts' assertions on the quality dimension of performance measures, each quality expert has their own philosophy on organizational upstream management. Even though experts' ultimate quality goals are centered on improving the quality of the process rather than product quality, and on emphasizing ongoing quality improvement efforts, each has a different approach for quality management of the organizational upstream system.

According to Deming (1985), inspection of incoming or outgoing goods is too late, ineffective, and costly. Inspection neither improves quality, nor guarantees it. And inspection usually allows a certain number of defects. Deming also emphasized sole sourcing because he believed multiple sourcing for protection is a costly practice. The advantages of sole sourcing include better supplier commitment, elimination of small differences between products from two suppliers, and simpler accounting and paperwork. This way, suppliers can produce materials that do a better job of fulfilling the needs of the organization. To maintain long-term contracts, suppliers will be more likely to improve their own processes to provide better products or services. Using a single source may mean paying a higher price, but Deming believed the policy of driving down the price of purchased items, without regard to quality and service, could drive good suppliers out of business.

Crosby and Juran recognize some of the advantages of single suppliers, but they take a more conservative view and simply advocate reducing the number of suppliers. Crosby and Juran consider it important to have different suppliers for the same product when the product is a critical one. That way, the organization will not suffer because of strikes, accidents, or other problems caused by suppliers.

In Juran's opinion, certain quality practices of the past should undergo extensive changes. One of these relates to organizational upstream management practices – strategic supplier partnerships. Juran advocates revised supplier relations: the number of suppliers should be reduced; a teamwork relationship, based on mutual trust, should be established with the suppliers; the traditional adversary approach should be abolished; and the duration of contracts should be increased.

Crosby also emphasizes the importance of managing the organizational upstream system and its quality. First, Crosby equates quality management with prevention. Therefore, inspection, testing, checking, and other non-preventive techniques have no place. By increasing efforts on supply management practices, only upstream management can prevent further quality problems. This prevention concept is equivalent to a

vaccination for our present and future health. Prevention is the only way to ward off organizational disease.

In the same vein, Crosby coins the phrase *Do it right the first time*. The *it* in doing it right the first time is the requirement. If we try to interpret Do it right the first time in the context of the organizational transformation process, the key is making customers' (q3) requirements clear to suppliers. To do this, managers of buying and selling firms have three tasks to perform: (1) establish and clearly communicate the requirements their employees are to meet, (2) provide every possible means that the employees need to meet those requirements, and (3) spend their time encouraging and helping employees meet those requirements.

Deming, Crosby, and Juran distinguish clearly internal and external customers. These three experts support the practice of involving suppliers in the quality effort. It is impossible to achieve quality when products or services provided by suppliers are inferior. These approaches also require using measurement and problem-solving techniques, but the emphasis on their use varies.

There are many other quality experts who emphasize the importance of the organizational upstream system and its management. Feigenbaum says "Quality is expected, not desired." By this, he means quality begets quality. Therefore, as one supplier becomes quality oriented, other suppliers must meet or exceed this new standard. Peters and Waterman (1982) highlight a customer-driven approach in their book *In Search of Excellence*. They advocate that excellent suppliers have an almost uncanny feel for what their customer wants. This is because they are a customer of their own products.

2.1.2 Organizational upstream management from historical perspectives

Quality management for highly effective organizational inputs in the organizational upstream system did not receive much attention until a systems approach to quality arrived in the 1970s (Yang, 1977). Of course, supply management for high quality organizational inputs existed in earlier organizational structures, but at a fairly low level on the organizational chart. Purchasing or supply managers' primary functions were regarded as

strictly clerical and were limited to sourcing, pricing, and delivery (Ansari & Modarress, 1994).

The responsibilities of supply managers' have changed since the early 1970s when U.S. firms started losing significant portions of the world market share and had to cope with new Asian and European competitors. Many experts on upstream management now agree the scope of upstream management should include selection of suppliers, acquisition, conversion, and distribution of the materials flow from suppliers to consumers, including raw materials, work in process, and finished goods. This new agreement on the concept and roles of upstream management must be interpreted in the same vein as the systems approach to management articulated in 1970s. Table 2-1 shows historical data on the supply management and purchasing development evolution in the United States since the inception of the supply management concept.

2.2   *Review of q1-q3 Partnerships*

This section describes q1-q3 partnerships in-depth by reviewing definitions and origins, followed by some reasons why organizations need q1-q3 partnerships. After that, key factors in q1-q3 partnerships are examined.

2.2.1   The definition and origin of q1-q3 partnerships

As briefly introduced in Chapter 1, the q1-q3 partnership represents a transactional/relational philosophy. This philosophy expands the relationship between q1 and q3 organizations beyond that typically found in traditional purchasing methodologies. A partnership involves long-term contracts, a reduced number of supplier sources, a high degree of intention, and sometimes, a changed paradigm, and the elements introduced in Chapter 1 – mutual trust, two-way communication, commitment, specific investment, and joint action between q1 and q3 organizations. These elements are partly (or, in some cases, fully) responsible for the shared results (role integrity, flexibility, conflict resolution, and mutuality).

Table 2-1. Historical Perspective on Supply Management and Purchasing Development
(Adapted from Ansari & Modarress, 1994)

Time	Event
1832	Charles Babbage develops the first materials management concept.
1915	The magazine *The Purchasing Agent* (later, *Purchasing*) emerges. National Association of Purchasing Agent (NAPA) (later the National Association of Purchasing Management - NAPM) is founded. Top management begins making major decisions on upstream system management, and plant foremen are often involved in supply management activities.
1929	NAPM develops a set of standard procedures for buying and selling.
1951	Stuart Heinritz's *This Business of Buying* defines supply management as a critical function.
1960s	Negotiation techniques, learning curves, cost/price analysis, inventory control, PERT/CPM networks, buyer training, and supplier evaluation become tools increasingly used by personnel in organizational upstream systems. Purchasing function is considered a profit center. First MRP is developed at American Bosch Company; orders tend to be in large lot sizes.
1970s	Oil embargo, material shortages, and escalating fuel and material costs contribute to an increased focus on the importance of supply management. Purchasing as a specialized task has been pushed to the top level in organizational structures.
1980s	Many Japanese approaches are implemented by many U.S. companies; orders tend to be in small lot sizes.
1990s	JIT purchasing, sole-sourcing, quality audits, and other (quantitative and qualitative) measurement tools are widely used by many leading companies.

Ellram (1990) has defined a strategic partnership as "a mutual, ongoing relationship involving a commitment over an extended period, and a sharing of information and the risks and rewards of the relationship." Another team of researchers (Landeros & Monczka, 1989, p. 8) found cooperative q1-q3 partnerships typically were characterized by five attributes:

- A supply pool consisting of one supplier or a preferred few,
- An alliance incorporating a credible commitment between the buying and selling firms,
- Joint problem-solving activities,
- An extensive exchange of information between firms, and
- Joint adjustment to marketplace conditions.

One of the critical success factors of a q1-q3 partnership implied by these attributes is that to be successful, the goals of the partnership must coincide with the strategic needs of both firms. Often, managers of one party focus on the importance of the relationship to their strategic goals and spend little time understanding the relevance of the relationship to the partner. This can lead to relationships that are central to the needs of one firm but peripheral to the interests of the other. Such partnerships are obviously at risk and do not address the major foci of upstream management as cited in Chapter 1.

Other than the term q1-q3 partnerships, some researchers use different terms, such as channel partnership and value-adding partnership. Bussell and Ortmeyer (1995, p. 85) define the channel partnership as "an ongoing relationship between the customer and the independent supplier in which the parties agree on objectives, policies, and procedures for ordering and physical distribution of the supplier's products." Similarly, the value-adding partnership is defined by Johnston and Lawrence (1995, p. 94) as "a set of independent companies that work closely together to manage the flow of goods and services along the entire value added chain."

Whatever term is used, how have q1-q3 partnerships evolved? Lamming (1993), based on his longitudinal data collection from interviews with managers of both q1 and q3

organizations, has proposed three previous phases (see Table 2-2) that explain the necessity of partnerships.

Table 2-2. Timescale for the Four Models of Customer-Supplier Relationships (Adapted from Lamming, 1993)

First phase	This period ended about 1975, before the impact of the oil shock and the resulting recession, and before the increase in international competition between world economic leaders and the rest. This period was relatively calm, with domestic demand and supply well balanced for mass producers.
Second phase	Between 1975 and 1980. This period was difficult for q1 and q3 organizations because demand fell and became unstable.
Third phase	This phase began in 1980. There were noticeably better attitudes towards relationships, but they were still difficult and unstable.

The third phase was not sufficiently progressive for best practice relationships. For example, neither side liked the exchange of information, because the customers' tendency to use cost data against suppliers in negotiation was still apparent, while suppliers found their intention of and attitude toward building more credible relationships could still not be trusted. This is one of the reasons why a new phase was necessary as is explained in the next section.

2.2.2 Why q1-q3 partnerships?

There have been many studies in which researchers examine the ineffectiveness of traditional supplier selection methods, e.g., the bidding process. Some of these studies are explained below.

Some authors have suggested that competitive bidding should not be used when major issues other than price are important (Dobler, Burt, & Lee, 1990, p. 12). Others have suggested that the philosophy underlying the competitive bidding approach to supplier selection leads to a higher cost in the long run (Hahn, Kim, & Kim, 1986). An

emphasis on price at the expense of quality and uncertainty about follow-up contract awards, with subsequent shorter production runs, can lead to a supplier environment in which avoidance of investment in technology, R & D, and capital equipment, all requiring long-term stability for adequate financial return, is commonplace. Competitive bidding, therefore, in some cases may lead to lower cost materials only in the short run, even when price is the primary selection criterion.

On the other hand, in today's rapidly changing environment, interest has grown quickly in an alternative to the competitive bidding process – supplier selection through partnership. This arrangement establishes and maintains an ongoing relationship between the two partners. To work, it requires information sharing, joint problem-solving activities, and mutual dependency (Womack, 1990, p. 146-156), some of which are explained below.

Competition under the partnership is dynamic in the sense that every q1 firm knows it must work with customers and outperform other companies providing similar services. The methods of surviving this competition, which are proposed in Chapter 1 as the five key factors, are different from those employed in the earlier phases of q1-q3 relationships as illuminated in Table 2-2. In the q1-q3 partnership, a preferred supplier should have a solid, long-term relationship with its customers and should know it must provide better service. The security of remaining a supplier to any customer is provided by fulfilling/exceeding customer expectations, not by maintaining the status quo.

Efficient information exchange is of fundamental importance to the success of the partnership. In Japanese q1-q3 relationships, the q1 and q3 firms can monitor, predict, and influence the levels of the return of assets, by using a constant exchange of operating and financial data (this is underpinned by the positions in keiretsu). Meanwhile, information exchange is a major challenge for firms in Western countries, where such clear and broad openness is not traditionally practiced, and strategic information rarely flows across the company's internal/external interfaces.

The involvement of the q3 (q1) organization in the process within the q1 (q3) organization also provides the basis for a partnership approach to price change. For example, Cusumano (1985) has noted the productivity of Japanese component supplier's rose as they received direct assistance from large automakers such as Nissan, Toyota, etc. The challenge of partnerships in this cooperative environment is thus significant for q1 and q3 firms. The idea of reducing costs, and therefore prices, is the direct consequence of joint action between q1 and q3 firms. This is made possible by long-term commitment, trust, and some form of financial investment from suppliers and customers. Once the concept of the customer's (supplier's) involvement in improving the supplier's (customer's) processes is established, the joint approach to total quality and productivity improvement becomes natural. These key factors are briefly introduced in Chapter 1, and they are explained in more detail in section 2.2.3.

The partnership is sometimes called the Japanese model[1] for two reasons. First, it was recognized that the way customers deal with suppliers was a major strength for Japanese q3 firms. Second, it became clear that Japanese q3 firms would have to set up plants, especially automotive assembling plants, overseas in due course and suppliers would need to agree with the new customers' terms if they wanted to deal with them. But it should be noted there are clear distinctions between Japanese and Western countries' economy structures. These structures have caused different q1-q3 relationships.

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[1] Whether it is the q1-q3 relationships in manufacturing or in service industries, the Japanese partnership model rests on three major assumptions: the q3 firm controls the relationships; the specialist abilities of q1 firms, that are not present in q3 firms, are recognized as crucially important; and it is necessary to have some sort of shared capital or financial tie in order to effect a secure relationship. (These three assumptions characterize the unique Japanese industry structure called *keiretsu*. It is beyond the scope of this research to delve into the concepts and implementation/deployment practices of the keiretsu.) Any model of q1-q3 relationships naturally reflects these three factors. For Western q1 and q3 organizations, there are some apparent limitations to adopting the Japanese way of working. Shared capital and financial ties had been created progressively in Japan in a protected industry rising from the ashes of the war with the benefit of a strong national determination to resurrect it. In the Western economy structure, and in q1-q3 relationships that have different assumptions and history, it would evidently not be easy to create a common concern for mutual benefit, or even survival (Cutts, 1992).

In summary, a q1-q3 partnership is a strong inter-company dependency relationship with long-term planning horizons. Table 2-3 shows the key contrasting elements between a traditional approach to the q1-q3 relationship and today's partnership.

Table 2-3. Traditional vs. Today's q1-q3 Relationships
(Taken from Stuart, 1993)

Traditional q1-q3 relationship	q1-q3 partnership
Primary emphasis on price	Multiple criteria including management philosophy
Short-term contracts	Longer-term contracts
Evaluation by bid	Intensive and extensive evaluation
Many suppliers	Fewer preferred suppliers
Improvement benefits are shared based on relative power	Improvement benefits are shared equitably
Improvement at discrete time intervals	Continuous improvement is sought
Problems are supplier's responsibility to correct	Problems are jointly solved
Information is proprietary	Information is shared
Clear delineation of business responsibility	Quasi-vertical integration

2.2.3   Key factors in q1-q3 partnerships

As briefly mentioned earlier in Chapter 1, the factors characterizing the q1-q3 partnership are not exhaustive because many more factors could be generated to reflect situational changes. Some other factors can be found in the relationalism literature in marketing, such as mutual goals, performance satisfaction, and structural and social bonds (Wilson, 1995). In this research, however, the five factors that have been most frequently identified and used to explain the q1-q3 partnerships are considered more important, and each is examined in more detail in this section.

2.2.3.1 Trust

Trust in q1-q3 partner relationships is considered "a fundamental relationship model building block and as such is viewed as a key factor in most partner relationships" (Wilson, 1995, p. 337). Most definitions of trust involve a belief that one relationship partner acts in the best interest of the other partner, as shown below:

- "One party believes that its needs will be fulfilled in the future by actions taken by the other party" (Anderson & Weitz 1990, p. 313).

- "A party's expectation that another party desires coordination, will fulfill obligations, and will pull its weight in the relationship" (Dwyer, Schurr, & Oh 1987, p. 15).

- "The belief that a party's word or promise is reliable and a party will fulfill his/her obligations in an exchange relationship" (Schurr & Ozanne 1985, p. 940).

The definitions of trust proposed here reflect two distinct components: (1) competence, which is based on the extent to which one party, especially the customer, believes that the other, especially the supplier, has the required expertise to perform the job effectively and reliably and (2) benevolence, which is based on the extent to which one party believes that the other party has intentions and motives beneficial to each other when new conditions arise, conditions for which a commitment was not made (Ganesan, 1994). Competence and benevolence have similar effects on long-term commitments, because both specific trusting behaviors and intentions are required to mitigate the perception of risk due to opportunistic behaviors.

2.2.3.2 Two-way communication

Communication linkages between q1 and q3 organizations are concerned primarily with the flow, volume, and quality of information (Landerous & Monczka, 1989). In the traditional arm's length transaction-oriented situation, the flow of information is limited and centers on the parameters of each contractual agreement. On the other hand, information must be exchanged to develop a credible commitment between q1 and q3 organizations in the partnerships. The exchange of information between two firms allows both firms to stabilize and coordinate their interdependence (Pfeffer & Salancik, 1978).

The partnership also provides a channel through which the supplier can obtain information about product design and demand schedules, and the customer is willing to provide such information to help promote mutual productivity improvements or lower total costs.

In a special type of partnerships, sometimes called keiretsu or vertical integration, there is a mutual exchange of information that allows for uniform management of total quality and productivity, which, in turn, differentiates this type of partnership from many other Western partnerships.

2.2.3.3 Specific investment

Specific or nonretrievable investment is investment or efforts made by one or both parties that are considerably less valuable outside the focal relationship (Wilson, 1995). The nonretrievable investment, such as capital improvement, training and education, and equipment, cannot be recovered if the relationship terminates.

One party's perception of the other's specific investment in a relationship signals that the partner is trusted. The investment also communicates strong commitment to the relationship. In other words, specific investments offer tangible evidence that the partner can be believed, it cares for the relationship, and it is willing to make sacrifices through such investment.

2.2.3.4 Commitment to a long-term relationship

Commitment to a long-term relationship is one of the most common factors used in q1-q3 partnerships. This is because commitment is important in discriminating between *stayers* and *leavers* (Mummalaneni, 1987). It is also the desire to continue the relationship and to work to ensure its continuation. Dwyer and his colleagues (1987) view commitment to long-term relationships as an implicit or explicit pledge of relational continuity between the partners.

The difference between short- and long-term commitment can be explained by the nature of the interfirm exchange adopted by two partners. Firms with a short-term orientation rely on the efficiencies of market exchanges to maximize their profits in a

transaction. This short-term transaction-oriented relationship involves discrete or short-term events, based on distinct points of entry and exit (MacNeil, 1980). On the other hand, firms with a long-term orientation rely on relational exchanges to maximize their profits over a series of transactions. One party's long-term orientation is distinct from the longevity of a relationship. Though duration of an existing relationship is likely to affect each party's long-term orientation, longevity in itself is not sufficient to capture the two party's long-term orientation (Kelley, 1983). In other words, the two party's long-term orientation in an existing relationship, rather than the length of the relationship, seems to be a better indicator of q1-q3 partnerships.

2.2.3.5 Joint action

Joint action, defined as the degree of inter-penetration of organizational boundaries (Guetzkow, 1966; Laumann, Galaskiewicz, & Marsden, 1978), is viewed in this research as the combined efforts of implementing and deploying all the key factors introduced above. Organizational boundaries are penetrated by integrating the key factors as the supplier becomes involved in activities that traditionally are considered to be the customer's responsibilities and vice versa.

Joint action in a q1-q3 partnership can occur over a large set of activities, including tool development and product design (Drozdowski, 1986), value analysis and cost targeting (Dowst, 1988), design and quality control and delivery systems (Treleven, 1987), and long-term planning (Spekman, 1988). As the extent and scope of joint action increases, q1 and q3 organizations effectively become partners in buyer-seller relationships.

In the language of the governance mechanism, joint action implies a departure from a market-based exchange as the roles of q1 and q3 organizations are no longer narrowly defined in terms of the simple transfer of ownership of a product or service. From the technology point of view, joint action is the degree to which one party values the technology contributed by the other partner to the relationship. This shared technology ranges from product level technology to the linking of computer systems for more efficient

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information exchange. The creation of shared technology has been found to strain a relationship in the early stages of the development of the technology, but inevitably it contributes to a stronger relationship when the technology is working (Vlosky & Wilson, 1994).

Any single tool, or the combination of three or four joint practices that have been identified as useful in increasing the performance of q1-q3 partnerships, cannot achieve the desired level of partnership uncovered in some world-leading companies, such as Ford, Xerox, and Toyota. This means any form of mechanism is required to use those joint practices effectively and efficiently in an integrated way. In Appendix A, some of the exemplary tools and joint practices for better q1-q3 partnerships are introduced in two groups – (1) how to build a desirable q1-q3 relationship and (2) how to improve the performance of upstream management – without an in-depth explanation on how to use them in an integrated way, which is beyond the scope of this research.

2.3   *Review of Environments for Better Result-Sharing of q1-q3 Joint Action*

The major difference between section 2.2.2 (Why q1-q3 partner relationships?) and this section is that Section 2.2.2 depicts a brief picture of current q1-q3 partnerships. In this section, some suggestions for and directions to the desired conditions and environments for better result-sharing of q1-q3 joint action are reviewed based on theoretical assertions and industry practices.

Based on their longitudinal data and collection and analysis, the work of the international group of university-based researchers known as Industrial Marketing and Purchasing (IMP) Group (Hakansson, 1982) has proposed an interactive model for q1-q3 relationships in which two parties are more likely to share the results of their joint action (see Figure 2-1). The focus of Figure 2-1 is on the long-term interaction process: institutionalization, adaptation, and relationships. The long-term interaction process is characterized by Ford (1978) as routinized, implying that each episodic relationship becomes a matter of expectation and behavior patterns which are taken for granted. Within the routinization of the relationship, IMP specifies the institutionalization of
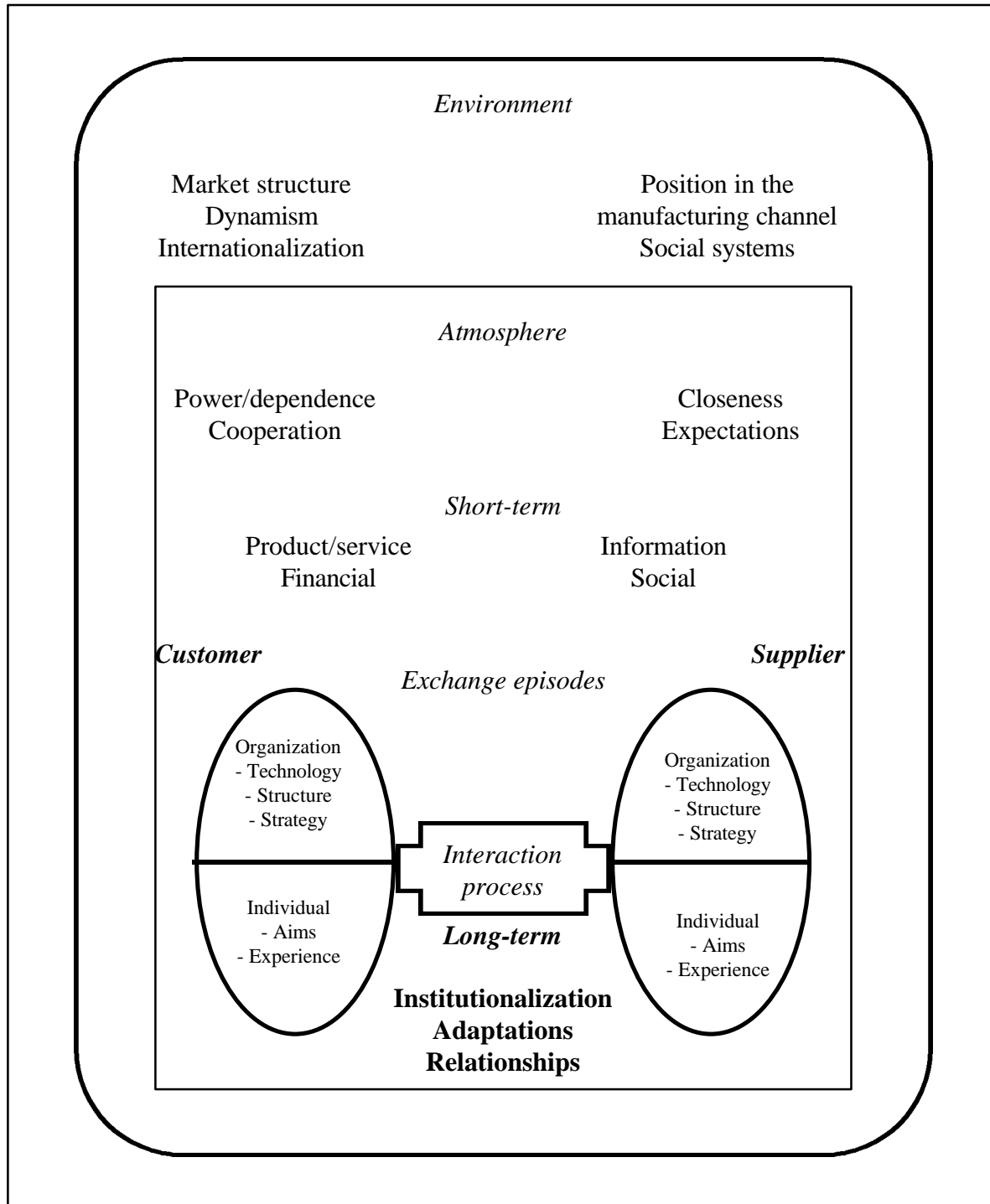
Environment

Market structure
Dynamism
Internationalization

Position in the
manufacturing channel
Social systems

Atmosphere

Power/dependence
Cooperation

Closeness
Expectations

Short-term

Product/service
Financial

Information
Social

Customer

Supplier

Exchange episodes

Organization
- Technology
- Structure
- Strategy

Organization
- Technology
- Structure
- Strategy

*Interaction
process*

Individual
- Aims
- Experience

Long-term

Individual
- Aims
- Experience

**Institutionalization
Adaptations
Relationships**

**Figure 2-1. IMP Interactive Model for q1-q3 Relationships
(from Hakansson, 1982)**

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expectations and contract patterns, and adaptations which each partner must make to propagate the relationship. Ford (1980) notes that the level of adaptation grows with the life of the relationship, with changes to practice becoming institutionalized and resulting in cost savings (mutual benefits for both parties).

Unlike the Japanese-style partnerships in which the customer and supplier firms have developed, in almost all cases, as senior and junior relationships, the customers and suppliers in Figure 2-1 enjoy the richness of an equal's contribution that is always required to maintain the relationships. Other than this distinction between the Japanese unique partnerships and the Western style partnerships, some future conditions and environments for better result-sharing of q1-q3 joint action are proposed by researchers (Lamming, 1988 and 1989). These are summarized here:

- The total number of suppliers will consist of significantly fewer companies. The size of each supplier will be bigger than the present company and will offer a broader range of services to its customers. The supplier will also take more responsibility in developing each industry. Other types of suppliers may be expected to play only minor roles in the industry.

- The supplier industry will be structured in tiers or separate levels, differentiated by the nature of the suppliers' connections to the customer, the level of the products technology for which they are responsible, and the complexity of the production and supply functions which they coordinate or control.

- There will be stronger and more common horizontal strategic relationships at the higher levels, linking suppliers through joint ventures, technology partnerships, supply agreements, etc.

- Competitive advantages for suppliers will continue to be based upon achievement of best practice, world-class manufacturing, incorporating the implementation of new technologies and working practices and continuous improvement. This will give the supplier leverage to reduce unit costs, improve quality, and develop new products and toolings in a fraction of the time taken traditionally.

These four factors (conceptual conditions/environments) can be operationalized, as shown below using several dimensions that relate to this study: (1) the nature of competition between suppliers, (2) the role and mode of data/information transfer, (3) dealing with price changes, (4) attitude to quality, (5) role of R & D, and (6) level of pressures.

2.3.1 The nature of competition between suppliers

One clear distinction in q1-q3 partnerships and non-partnerships is that competition between suppliers will be increasingly global and part of the partnership must be a readiness for the partner of the supplier to provide an immediate service to the customer wherever and whenever it is required. This comprehensive support may be in the form of setting up a necessary facility close to the customer's location or through joint ventures. The supplier must form strategies for global coverage separately from the requests of its customers. Rather than simply following the customer, the supplier has to decide for itself how to balance a portfolio of customers and relationships to exploit its resources and assets in a complementary way, in several directions at once.

The principle of a supplier contributing to product technology, via the medium of collaborative effort with the customer, is now accepted and practiced. In the proposed new environments for better result-sharing, the supplier has to be the technology leader, innovator, and the proactive partner.

2.3.2 The role and mode of data/information transfer

As the dynamics between customer and supplier become more complex, and the competition among suppliers within the same or across other industries is becoming intense, the supplier must recognize the importance of data/information and use them as tactical weapons. First, the supplier must relate its own business to the sales market of its customer. This requires initiative in assessing that market and also confidence in the information provided by the customer. For this to be the case, the supplier needs to understand the end market in general and the specific factors which relate to its business. For example, a manufacturer of microelectronics may know the most about the potential

use of microprocessors in telecommunications, but must work with the customer of such technologies with regard to the eventual customer.

Second, the supplier should be able to work with more than one customer in confidence. The degree of reliance upon the supplier on the part of the customer suggests a threat – strategic information could leak from the supplier to a competitor. This is because the nature of the end product provides a form of security for the customer in this respect. Therefore, the supplier will protect technology developed with one customer from reaching another, at least until it becomes public domain. The confidence built within the partnerships provides the basis for full use of electronic data interchange (EDI), without the fear of privacy mentioned above. The need for the component supplier to deal with many customers remains a problem, however, and it is expected that further technical developments in EDI will be pulled by the spread of partnerships.

2.3.3   Dealing with price changes

Joint effort towards cost reduction form a key part of the information exchange in partnerships. There will be a combination of working pressure and cooperation, coupled with transparency in costing (i.e., both parties being aware of the relevant parts of the cost structures of each others' process and the implications for one by a change in the other). For this area, the technique of value analysis[2] plays a vital role. This is because value analysis works only with accurate information on costs. This is obtainable only via good teamwork, i.e., between accountants and manufacturing engineers, and between customers and suppliers. The identification of costs, which is central to present and future partnerships, makes value analysis an especially powerful technique. In partnerships, the process of value analysis is extended to the supplier in order to identify specific needs for cost reduction, which become the targets of attention for both parties working together.

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[2] For value analysis to work, the customer works backwards from the market price of goods/services through to the maximum price that must be paid for each input from the supplier. This is then used in the relationship between q1 and q3 organizations.

In Japanese practices in the 1950s, Japanese firms enjoyed cost reductions through cooperation in customer-supplier relationships (Lamming, 1993). In partnerships, this process is incorporated and blended with the need for mutual benefits. Thus, as material supply or economic pressures force cost increases on the supplier, it is the joint responsibility of the partners to find ways to counteract the problem. The skill required by both parties is to ensure that ways are found to constantly improve the process and thus reduce the costs. (This is similar to the Japanese kaizen concept.)

If this concept is seen as a partnership, rather than as the traditional ultimatum issued by customer to supplier, the true nature of partnerships emerges. Cost reduction (and hence lower prices) can be achieved only through collaboration. An agreement on sharing the benefits of kaizen is required between the customer and supplier in order to make this process work. Careful use of the process leads to a situation as is seen in some world-class companies.

2.3.4 Attitude to quality

The approach to quality observed in the first, second, and third phases of customer-supplier relationships in Table 2-1 may be characterized as aggressive and dogmatic. Twenty years of this approach is a range of supplier quality rating schemes which require suppliers to perform in accordance with specific targets. The idea of partners constantly monitoring one another is contrary to the partnerships of the 1990s. It makes no sense for the customer to be constantly checking up on its partners.

However, in partnerships, the ability to provide product quality at defect levels measured in parts per million (so called *six sigma quality*; Harry, 1986) is an entrance criterion. Once this level of quality has been achieved, the relationship exists on the assumption that quality levels will be constantly improved. The customer-supplier relationship is only concerned with the subject when there are problems which warrant joint efforts to solve. As in some of the other factors, the supplier is required by the relationship to lead in quality control initiatives, not simply to follow the instructions of

the customer. This changes the partnerships into more of a true collaboration. It also lessens the likelihood of the supplier being seen as the junior partner.

2.3.5 Role of Research & Development (R & D)

R & D practices provide the most important link between customers and suppliers in partnerships, since it is one of the clearest manifestations of collaboration on the part of both partners. For the customer, a move towards the ideal partnership requires a new approach to becoming interdependent with the supplier. For the supplier, increased activity in R & D must be based on the belief the customer will not exploit the results of that activity unreasonably.

This may be called a trusting relationship. In the partnership, trust is a vital factor. It is a matter of mutual agreement on the principles and important points, transparency of information, and corrective behavior. As the customer requires the supplier to develop engineered solutions to any problems and requirements, suppliers may be expected to become the acknowledged specialists. Customers in the partnerships turn their attention to core activities in the products, relying on suppliers to develop sub-assemblies and functional sub-systems. In this way, duplication of effort is removed and the most appropriate assets and resources are applied to the proper tasks. At the same time, customers reduce the number of suppliers with whom they wish to work, thus concentrating the technical responsibilities further into the remaining partners.

From all the points made earlier in this section, it is clear there will be a great deal of pressure to perform to the very high levels expected within partnerships. The nature of this pressure appears to stem from two sources: self-imposed and customer-imposed. The point here is that the two parties must drive themselves harder than the partner does.

2.4 q1-q3 Partnerships in the Context of Two Organizational Development and Change Theories

This section reviews q1-q3 partnerships from the broad perspectives of two theories of organizational development and change: teleological theory and dialectical theory[3].

In teleological theory, the changing q1-q3 partnership is viewed from the teleological, or the philosophical, doctrine that a purpose or goal is the final cause for guiding movement towards today's q1-q3 partnerships. This approach underlies many organizational theories, including functionalism (Merton, 1968), decision making (March & Simon, 1958), voluntarism (Parsons, 1951), social construction (Berber & Luckmann, 1966), and most models of strategic planning and goal setting (Chakravarthy & Lorange, 1991).

Based on teleological theory, if the development of q1-q3 partnerships proceeds toward a goal, customers and suppliers are more likely to share the results of their joint action in a cooperative way. Thus, in the combined context of teleological and goal setting theories, the development of a q1-q3 partnership is viewed as a repetitive sequence of goal formulation, implementation, evaluation, and modification of goals based on what was learned or intended by both customers and suppliers. Although the intention, or purposiveness, of q1-q3 partnerships is stressed in a teleological sense, this theory also recognizes the limits of actions taken for a better implementation/deployment of the intention of managers of customer and supplier firms. This can explain why there have been different types of customer-supplier relationships since the 1950's, as shown in Table 2-2.

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[3] There are other theories that can explain the activities, events, etc., related to organizational development and change. Other theories proposed by many researchers in psychology, sociology, education, business and economics, and biology, medicine, meteorology, and geography are: (1) life-cycle theory by Comte (1978-1857), Spencer (1820-1903), and Piaget (1896-1980) and (2) evolution theory by Lamarck (1744-1829), Darwin (1809-1882), Mendel (1822-1884), and Gould & Eldridge (1977-present). These researchers are pioneers in organizational development and change theories. For more information on organizational development and change theories, see Van de Ven & Poole (1995).

Once the intention and goals are achieved, this does not mean the customer-supplier relationship stays in permanent equilibrium. Goals are reconstructed based on new pressures and competition from changing business environments. This is why today's q1 and q3 firms are more willing to rely on partnerships than ever before.

In teleological theory, it is assumed that the transition from one type of q1-q3 relationship to another is carried out smoothly at the levels of both industry and society. On the other hand, in dialectical theory, it is assumed that multiple q1-q3 relationships compete with each other for domination and control. In other words, dominant use of one type of q1-q3 relationship (the q1-q3 partnership in the case of this study) is explained by reference to the managers' preference for that specific type of q1-q3 relationship. However, changes can occur whenever the benefits and advantages of a different type of q1-q3 relationship dominate those of the previous one, and subsequently, results in a new and synthetic type of q1-q3 relationship.

Whatever changes and paths occur in q1-q3 relationships based on the evidence presented in sections 2.1, 2.2, and 2.3, it is reasonable to assume that there are key factors that characterize today's q1-q3 partnerships. Once this assumption is accepted either statistically (this has already been done by many researchers in the marketing-relationalism area) or socially, it is a natural process to focus on the benefits of the q1-q3 partnerships to test and verify if today's q1 and q3 firms and their managers are using this relationship wisely and effectively.

2.5   *Tools and Joint Practices*

This section introduces tools and joint practices used in q1-q3 relationships. Tools and joint practices introduced in this section are summarized from (1) practitioner-oriented literature that is based on real-world cases or examples and (2) previous Senate Productivity and Quality Award (SPQA) applications.

2.5.1   Tools and joint practices identified in the literature

Currently, many books and papers relate the success stories of certain organizations' upstream management. These success stories and practices can serve as models for other organizations. However, the scope of their use of joint practices is confined to how many joint practices they used and the influence of their successful upstream management to other organizations.

A major American company estimates that 40% of its quality problems come from parts supplied by its suppliers.   A Japanese firm had to recall 45,000 washing machines due to fires caused by a supplier's defective capacitors, and the investigations into the Challenger and Chernobyl accidents revealed procurement policies that often undermined quality (Pence & Saacke, 1988). Supply setbacks like these have severely hampered many companies' efforts to upgrade quality and become more competitive. So, why don't quality-conscious companies do a better job of selecting suppliers who share their ideas and are willing to commit to the quality of their customer organizations? The purpose of this section is to provide specific examples to demonstrate how some leading U.S. companies solve quality problems by effectively using certain joint practices. These companies have been successful in managing q1-q3 relationships as well as improving specific organizational performances, and were selected as representative examples to highlight their specific practices.

2.5.1.1 JIT practices of members of the Association for Manufacturing
Excellence, Inc.

Giunipero (1990) has examined how experienced Just-In-Time (JIT) managers and their JIT purchasing practices can track quality costs and their impact on scrap and rework, plant efficiency, and customer return costs, as well as on traditional incoming inspection costs. His research was based on questionnaire responses from 100 practitioners in organizations that were active in implementing JIT purchasing. Most of the practitioners are members of the Association for Manufacturing Excellence, Inc.

Under the JIT purchasing environment, buying organizations continuously need to motivate their suppliers to improve their performance. Table 2-4 shows what other joint practices are used and how they are used in combination with JIT purchasing. These results show that to succeed in JIT purchasing practices, managers in the upstream system should consider both quantitative and qualitative joint practices to motivate suppliers. One of Guinpiero's results shows how quality issues are important in evaluating JIT suppliers.

Table 2-4. Joint Practices Used To Motivate JIT Suppliers
(from Giunipero, 1990)

Formal quantitative rating systems	n=43
Open & frequent communications	n=13
Supplier performance reviews	n=9
Long-term relationships	n=7
Stressing future benefits	n=5
Competition	n=4
No comment	n=7
Miscellaneous	n=5
Total respondents	**n=93**

Table 2-5 shows buying organizations' plans for refining and developing the future evaluation of their suppliers' performance. Quality is by far the most frequently mentioned performance factor. Results indicate JIT purchasers use a variety of tools to evaluate and motivate suppliers. The quality factor has assumed increasing importance in JIT operations. Consequently, most of the companies investigated in this research have adopted a broader view of quality because they realize that supplier quality impacts production efficiency, administrative costs, and ultimately the company's customers.

2.5.1.2 Caterpillar's 'Quality Institute'

Caterpillar, Inc. has a unique approach to educating its suppliers in quality improvement techniques. It designs formal and teachable seminars built around what

suppliers need to do to meet quality goals. The seminars are customized by including examples from Caterpillar's own manufacturing operations. These seminars are delivered

Table 2-5. Plans For Future Evaluation Systems For JIT Suppliers

Future evaluation system dimensions dimensions	Number of responses
Quality	21
Delivery	16
Price/cost reduction	6
Data processing/computer	6
Vendor certification/vendor qualification (on-site audits, supplier visits)	6
Communications	3
Line shutdowns/manufacturing integration	2
Percentage of Freight cost	1
Inventory	1
Technology	1
Total responses	104

to supplier representatives in a way that transforms them into trainers for their own company's personnel. This is why the Caterpillar's seminar course is called the *train-the-trainer course*. Through this seminar, the Caterpillar's Quality Institute has trained more than 1,000 suppliers who have already achieved Quality-Assured Certification. These certified suppliers are now on the preferred supplier list, and they are working for Caterpillar as its preferred suppliers. The purpose of Caterpillar's Quality Institute and its education program is to improve quality and reduce costs by showing the suppliers how better quality through upgrading their efficiency makes more money.

2.5.1.3 Bell & Howell DMPC's 'Strategic Supplier Partnership' through 'Supplier Certification Program'

One of the Bell & Howell DMPC's business strategies is to do more business with fewer suppliers. Naturally, certification becomes essential for suppliers who wish to continue doing business with Bell & Howell DMPC.

This company has its own processes for granting certifications to superior suppliers. Suppliers that are rated high in a preliminary assessment are invited to submit a detailed, written quality plan. Then managers in purchasing and their staff look for supplier quality plans that complement Bell & Howell's own business plans. After this screening, the Bell & Howell team goes to the vendor for an on-site audit to determine whether the company is doing what its plan says it is doing. If the plan is accepted and the vendor is certified, it must be recertified every year or two.

In Bell & Howell DMPC, certification means a multi-year partnership of up to five years, and in some cases, certified suppliers will handle 100% of Bell & Howell DMPC's business for a its specific commodity. This simplifies manufacturing schedules for the suppliers and for Bell & Howell DMPC.

2.5.1.4 GTE's 'Partners in Quality' Program

GTE's example of involving suppliers in setting quality goals of supplied parts shows how quality problems can be solved by building quality in the early stage of business between buying and selling organizations.

GTE's *Partners in Quality* program works in this way: In December of each year, GTE sends a set of product-specific goals to each major supplier and asks that they be filled out and returned by January 31st. Historical data (benchmarks) for each goal must be given and a quarterly submission of progress is required. Benchmark data is entirely generated from the supplier's own product tracking system in order to encourage timely and accurate data recording and analysis. Initial goals are reviewed at a 1st quarter meeting between the suppliers quality manager and the GTE quality representatives assigned to that product type. Where the GTE manager feels that a goal is overly

conservative, the supplier will be asked to review, and possibly elevate, the target. Where a goal seems excessively optimistic, the supplier will be asked to provide an analysis showing the specific steps planned to accomplish the change. *Stretch* goals are encouraged, but must be attainable in order to prevent suppliers from ending the year with disappointing results.

As a result of this program, GTE obtained about 20% quality improvement. This program can be applied to a wide range of products and by any company willing to do a little homework on its suppliers critical processes. Knowing what goals are mutually beneficial and presenting these in a positive way with a win-win example will usually get the cooperation necessary (Morgan & Zimmerman, 1990).

2.5.1.5 Other organizations

Organizations have different approaches to their superior supply management activities. One thing to note is that almost every company mentioned above is using at least two of the tool/joint practices among those introduced in Appendix A. For example, member companies of the Association for Manufacturing Excellence, Inc. are using JIT purchasing practices and quantitative rating systems. Both Caterpillar and Bell & Howell DMPC are using supplier certification programs and their own education or stringent quality audit programs.

Many other examples of successful supply management practices are found in the literature. For example, Corning Inc. is using a strategic supplier partnership tool to select a few, preferred suppliers with whom it can do business. One of Corning's unique ways of selecting these superior suppliers is to go through its own quality audit processes using the Malcolm Baldrige National Quality Award Criteria (NIST, 1996).

On the other hand, one Illinois-based company, Outbound Marine Corp. (OMC), is extensively using an objective, quantifiable supplier rating system that lets suppliers know where they stand against competitors in terms of delivery and quality. OMC has developed a rating system that accurately assesses supplier performance and quality. It provides a consistent measure that does not vary from buyer to buyer, or from day to day.

For this rating system, the quality control department and purchasing department have input in developing the statistical reporting system. Purchasing coordinates its rating efforts with corporate and plant manufacturing, engineering, and quality staff. One of OMC's strengths is that this instrument not only takes into account rejects and delivery rating, but assesses the supplier's engineering capabilities and processes.

2.5.1.6 Summary and review of examples from the literature

The examples introduced show different approaches across several industries. Even though the joint practices and philosophies are different from others, there are important similarities among these companies (Pence & Saacke, 1988):

Management commitment: In most of the companies, quality is not an imposed management policy, but rather a way of life. The drive to survive is creating a new generation of managers for whom quality is second nature. They may not know everything they need to do to achieve it, but they know that it must be done.

Better supplier relationship: Companies described here share the belief that better supplier relationships are the key to better quality, although they markedly differ on what those relationships can or should be. Effective buyer quality management activities seek to end adversarial buyer-supplier finger-pointing, and point the way to mutual achievement of quality goals.

Supplier knowledge is power: The knowledge of suppliers' capability to produce or provide what they need is the baseline from which those companies begin to establish satisfactory supplier relationships. Effective buyer quality management activities are predominantly informational activities that improve their ability to influence the supplier's quality.

Supplier certification: One step on the way to zero-defect suppliers is to determine their capability to perform to a quality standard and to periodically verify that they are doing so. This supplier certification is found to be a key facet of most of the companies' quality programs, although there are considerable differences in what supplier certification is called, how it is used, and which standards are employed.

Quality improvement: To bring suppliers into the quality fold, these companies lead by example, deploying extensively quality improvement programs in their own operations and providing training and consultation to help their suppliers do the same.

2.5.2   From the Virginia SPQA applications

In the commonwealth of Virginia, there is an annual productivity and quality award competition among excellent companies in private sector manufacturing, private sector service, public sector state and federal agencies, and public sector local agencies. This award is called the *U.S. Senate Productivity and Quality Award (SPQA).*

The researcher has studied previous SPQA winners' applications and other related data and information to examine what they have done to manage and improve upstream systems and how this has been accomplished. Most organizations introduced as examples in this section are private sector manufacturing companies. One reason for selecting manufacturing companies is that it is easier to observe the manufacturing companies' upstream management practices than to observe state and federal, or local agency organizations' upstream management practices in the area of service. (More information on the SPQA and its selection criteria are provided in Appendix B.) This section summarizes information related to upstream management practices, collected from SPQA-related materials (the SPQA application and other company information such as brochures and pamphlets).

2.5.2.1 Canon Virginia, Inc. (CVI)

CVI, winner of the SPQA in 1994 and located in Newport News, Virginia, produces copiers, laser printers, printer cartridges, toners, and component parts for the U.S. and export markets.

One of its supply management efforts has been to locate much of the production of key parts and raw materials close to CVI. This was done by selecting and developing appropriate domestic supplier partnerships and by establishing subsidiary factories nearby. Selecting and developing reliable domestic suppliers was established as a priority from the

beginning of operation in Virginia. While it seeks new suppliers when necessary and appropriate, CVI is working hard at narrowing its supplier base to the best in terms of environmental responsibility, quality, cost and delivery. The active search for qualified domestic suppliers has been successful so far. Currently, well over half of its parts and raw materials are now procured domestically. Its cartridge line now stands at 73% of domestically produced parts. Reducing transportation time and expenses have allowed CVI to schedule deliveries more accurately and aggressively.

Current or potential suppliers are given the opportunity to tour its subsidiary to see a model supplier at work. This procedure establishes open communication from the onset of their relationship. As a result of these efforts, supplier improvements have increased on-time delivery performance from approximately 50% in 1990 to 88% in 1993. CVI also sees ISO certification and its continuous improvement process as another important step toward its development as a world class manufacturing company, and this effort was rewarded by officially being granted ISO 9002 certification.

CVI's key performance indicators include measures of process and product quality, process efficiency and performance, and supplier performance. These indicators measure its progress in optimizing the critical success dimensions of quality, cost, and delivery. Begun in 1991, regular supplier performance evaluations are the primary means by which CVI tracks and communicates with suppliers. Each supplier is given a monthly performance rating based on received quality levels, cost performance, delivery performance, and interaction between CVI and supplier technical staff members. An annual award system for superior supplier performance has been developed. In addition, periodic supplier conferences help CVI because they can discuss production forecasts, new technologies, current events, and other supplier related issues. Also, CVI is developing a quality certification process designed to recognize world class suppliers.

All its efforts in supply management are expressed in one of its commercial brochures:

Canon Virginia's goal is to provide our customers with the best quality products, on time and at reasonable cost. In order to meet this goal, we rely heavily on our suppliers –our partners in production.

As an extension of the Canon family, suppliers must meet the same demanding quality standards that we follow. We accept only the highest quality parts, and in order to keep production at its peak, we expect just-in-time delivery. Our average inventory is used in only three to five days. Some supplies are delivered and used daily.

Canon Virginia is committed to building long-term relationship with our suppliers so that we can grow and develop together. Our evaluation of potential suppliers goes beyond the quality of their products. We also explore their business philosophy so that we can work together with supplier companies that share our energy and enthusiasm for total commitment to quality. We regularly provide feedback and recognize suppliers yearly on the basis of total performance evaluation. Many suppliers have demonstrated their commitment to Canon Virginia by investing in new facilities and technology in order to meet our needs. Some suppliers are exploring opportunities to open facilities nearby so that Canon Virginia can be more efficiently served.

We believe that through this mutually beneficial relationship, Canon Virginia and our suppliers will continue to together strive for excellence.

2.5.2.2 Sara Lee Knit Products–The Galax and Hillsville Plants

This company was formed in 1903 in Winston Salem, N.C., and opened sewing operations in Galax and Hillsville, Virginia in 1955 and 1990 respectively. From the beginning, Sara Lee Knit Products was recognized as a leader in manufacturing quality knit underwear for men and boys. Sara Lee Knit Products won the SPQA in 1994.

Sara Lee Knit Products has an ongoing process to reduce the number of external suppliers. It believes in the concept of partnerships with suppliers for their mutual benefit. One of this company's intentions is to maximize its business with suppliers who consistently exceed agreed upon levels of product quality, delivery, and product cost. Its supplier certification process naturally leads to a reduction in the overall number of suppliers and to an improvement in the quality levels of those remaining. Additionally, this company continues to audit suppliers at their locations to ensure adherence to specifications. Results of these audits generate supplier performance ratings which are

provided to the supplier and are a major factor in determining who its external suppliers will be for the future. Recognition for superior supplier performance comes in the form of increased business with Sara Lee Knit Products.

As part of its partnership, suppliers make regular visits to its manufacturing facilities to view their product in its production process. This leads to improvements in the raw material, providing for a higher quality product to the customer.

While raw materials suppliers are important, of equal importance are its machinery suppliers. Machinery suppliers, together with Sara Lee management and production associates, meet regularly to review new equipment needs and proprietary equipment modifications to improve product quality and production efficiency.

2.5.2.3 Dana Corporation, Spicer Axle Division

Founded in 1904 as a pioneer U.S. automotive industry supplier, Dana is a global leader in manufacturing and marketing of vehicular and industrial components, and today features a worldwide products and customer service base for manufacturing and distribution facilities located in 27 countries. The Spicer Axle Division of Dana Corporation won the SPQA in 1992.

In the Spicer Axle Division, supplier quality assessment is a two-pronged strategy of on-site system surveys and delivery performance. The Spicer Axle Division has a formal supplier Quality Site Survey in which suppliers are surveyed, ranked, and potentially awarded a *Certified Supplier* status. A plaque in its lobby honors suppliers that have achieved this recognition. This program is formally augmented by its receiving audit, in which suppliers earn statistically less frequent audits as evidenced by their quality and delivery performance progress. Individual suppliers maintain their certification by maintaining outstanding performance.

Its Buena Vista facility regularly hosts Quality Assessment visitations from its customers, and has been awarded Ford's Q1. They are actively pursuing Ford's Total Quality Excellence award within its division. The Buena Vista facility is also recognized by General Motors as a Targets for Excellence Quality award winner. Chrysler has

granted the Buena Vista facility a *self certified* supplier status based on their assessment of its performance and survey results.

As a result of these on-going efforts for a more effective upstream system as a supplier for its customers and a customer for its suppliers, the Spicer Axle Division in Buena Vista has decreased its suppliers rejection rate from 5580 PPM in 1989 to 1930 PPM in 1993. It also increased its suppliers' percentage of on-time deliveries from 50% in 1988 to 98% in 1993.

2.5.2.4 ITT Defense–Electro-Optical Products Division (EOPD)

ITT EOPD is the world's leader in the technology and production of the Generation III image intensifier, a state-of-the-art device that enables humans to see in the dark. Since the early 1950s when the initial Gen 0 production technology was transferred from Fort Wayne, Indiana to Roanoke, Virginia, the Roanoke plant has maintained a continuous image intensifier production activity. ITT EOPD won the SPQA in 1990.

To assist vendor selection and measure past performance, a vendor rating system is maintained based on the vendor's ability to meet specifications and purchase order requirements. The ITT EOPD vendor quality engineers are in frequent contact with suppliers in order to help with inspection techniques, SPC training, Taguchi experiments or provide any other assistance required to help suppliers meet the purchase order requirements.

In addition to the quality improvement in vendor-supplier material, ITT EOPD enjoys a two-way relationship with its suppliers in that ITT processes have also been improved through assistance provided by the vendors. Significant among these have been indium process improvement resulting from in-plant visits by the vendor, reduction in cathode defects through in-depth participation with gallium-arsenide vendors, and optical design and analysis by optics manufacturers.

All its efforts in upstream management have involved ITT EOPD's vendor quality engineers, product manufacturing engineers, and material purchasing personnel. The result of these efforts have proven beneficial to the vendor through improved in-house

production yields, to ITT EOPD through a reduction in rework, reduced variability in component parts, smoother production flow, and to the government through a more timely and consistent delivery of Gen III products.

2.5.2.5 *Practices from other SPQA winners*

Organizations and their upstream system practices other than those mentioned earlier are numerous in both the manufacturing and service areas.

For example, TRW Systems Division in Fairfax, Virginia (the 1991 SPQA winner), provides systems engineering, software development, and systems integration services to the federal government, and has focused on two extreme points of the organizational transformation process – customer and supplier – as the first step of its continuous improvement process. Its strategic performance improvement planning process starts with identifying customers and suppliers, and their needs and requirements. Naturally, its definition of the supplier includes anyone inside and outside the company who provides material or information that its work groups need to produce its products.

Another example of a successful supply management practice in the service area can be found in Sentara Health System's (1992 SPQA winner in the private sector service area) supply management practice. This company assesses supplier quality through Continuous Quality Improvement teams, termed *Value Analysis Committees*. These committees conduct studies of quality and costs, and then evaluate suppliers based on their study results. For example, the Radiology Value Analysis Committee evaluated X-ray films and determined that the one they were using was of lesser quality and of higher cost than that of a competitor. They developed a new customer-supplier relationship based on this study.

There are more examples of successful upstream management practices in both the manufacturing and service areas. However, describing all of them is beyond the scope and purpose of this research.

2.6   Selected Performance Results of q1-q3 Joint Action

In this section, actual and exemplary q1-q3 joint action practices are reviewed for two purposes: (1) to identify tools and joint practices that are actually used in real q1-q3 partnerships and (2) to categorize them in a meaningful way. To achieve these purposes, all materials used here are the results of case studies, surveys, and other research activities based on actual q1-q3 joint action, not including theoretical assertions and arguments. Table 2-6 shows the summary results of the literature review on various tools and joint practices with respect to the type of industry, specific performance results, and so on. To derive meaningful information about tools and joint practices in the context of three industry types − manufacturing, service, and overall − the tools and joint practices identified in Table 2-6 are analyzed and categorized under the three industry types, and Table 2-7 shows the result.

Some conclusions from Table 2-7 are (manufacturing: M, service: S):

- Tools/joint practices frequently used, regardless of industry types, are: QFD (M:3 and S:2), JIT purchasing (M:3 and S:1), supplier performance evaluation (M:2 and S:1), joint (specific) problem-solving activities (M:2 and S:3), and education and training programs (M:1 and S:1).

- Based on the first finding, the manufacturing industry seems to rely on QFD, JIT, and supplier evaluation programs more than the service industry does, whereas two service industry uses form of joint action committee or team more frequently than the manufacturing industry does.

- One unique approach is used in the service industry: a team of multiple suppliers.

Based on Tables 2-6 and 2-7, three general trends have been derived. First, the manufacturing industry is more likely to use specific tools in terms of steps and procedures associated with their usage such as QFD, JIT, and supplier evaluation programs. To use QFD, the user is required to follow steps and procedures already identified and suggested by experts. In the case of JIT and supplier evaluation programs, the user in the manufacturing industry usually uses specific technologies and performance measures. This

Table 2-6. Tools/Joint Practices across Manufacturing and Services Industries

Source and type of research design	Type of industry	Tools/joint practices used	Performance results (shared results) or significant outcomes
Ansari A. and B. Modarress (1994). IJPMM; Literature research	Manufacturing	q1's involvement in q3's QFD	q1's provision of expertise in analyzing customer requirements, close working relationship to resolve any inconsistency in the process
Chen, B.A. and Batson, R.G. (1996). 50th ASQ Annual Quality Congress Proceedings. Case study	Manufacturing	Joint problem-solving team	q1's gain: improved quality, customer service, new technology development, reduced defect rate, more and better use of SPC tools, development of partner relationship q3's gain: improved documentation on q1's delivery, improved quality of final product, reduced inspection cost of outgoing products
Cayer, S. (1990). Purchasing; Case study	Manufacturing	q3's quality education/ training program for q1	Not specified
Cross, J. (1995). Harvard Business Review; Case study	Service	A team of multiple suppliers	Prolonged contract period (initiation of partner relationship), sharing of cost savings, greater flexibility and higher quality of q1's service, q1's technical competency and provision of skills and ideas
Giunipero, L.C. (1990). IJPMM; Literature research	Manufacturing	JIT performance measurement	Less use of cost/price measures, more use of number of suppliers/supplier lead time/supplier quality and delivery/inventory turnover/inventory reduction in total dollar volume
Graham, T. Scott, P.D. Daugherty, and W.N. Dudley (1994). IJPMM; Case study	Manufacturing	Long-term commitment	Decreased average lot size/number of suppliers/number of source per item Increased average contract agreement length/frequency of delivery to plant/supplier involvement in quality certification program Improved quality of supplier's operations (processes), improved quality of incoming purchased items, decreased supplier's/customer's total cost, improved supplier's (customer's) ability to handle customer-(supplier-) initiated delivery schedule change
Hauser, J.R. (1993). Sloan Management Review; Case study	Service	QFD	Reduced product price, more effective R & D activities in meeting customer's needs
Johnson, S.G. (1989). ASQC Quality Congress Transactions; Case study	Manufacturing	Supplier evaluation program and joint goal setting (planning)	Average gain: overall field return rate (17%), re-return rate (14%), no trouble found rate (19%), computerized tracking (16%), process SPC (11%), product SPC (13%), design SPC (33%)
McMillan, John (1990) California Management Review; Case study	U.S. and Japan auto industry (Manufacturing)	Incentive systems (q3's specific investment, risk sharing, multi sourcing)	Fewer suppliers, q1's earlier involvement in q3's product design, more monitoring of q1's quality
Raia, Ernest (1990). Purchasing: Survey	Manufacturing	JIT purchasing and delivery	q3's rework reduced by 24%, scrap rate reduced by 21%, WIP inventory reduced by 31%, manufacturing cycle time reduced by 50% q1's quality improved by 26%, costs reduced by 11%, lead-time reduced by 29%
Schonberger, R.J. and A. Ansari (1984). IJPMM; Case study	Overall	JIT purchasing	Frequent deliveries of smaller lot sizes, supplier evaluation based on product quality, single sourcing in closer geographical area, long-term relationship with fewer suppliers, supplier's improved quality
Stuart, F.I. and P. Mueller, Jr. (1994). IJPMM; Case study	Service	Joint problem-solving team and partnering	Increased q3's productivity by about 7.5%

Table 2-6. Tools/Joint Practices across Manufacturing and Services Industries (cont.)

Source and type of research design	Type of industry	Tools/joint practices used	Performance results (shared results) or significant outcomes
Sullivan, L.P. (1988). Quality Progress; Case study	Within organization (Overall)	QFD	Identification of better means (tools) to ensure desirable results, policy management
Morgan, J.P. and S. Zimmerman (1990). Purchasing; Survey	Service (Document management)	Supplier certification program (by their own standards)	Multiyear partnership, sharing of responsibility on specific commodity
	Manufacturing	Supplier qualification (MBNQA)	Establishment of exemplary benchmarks and measures
	Manufacturing	Supplier performance evaluation program	Provision of guidelines for other companies
	Manufacturing	Partnership with a few preferred suppliers and certified supplier award system	Reduced lead-time, better forecasting, open communication. Increased scrap savings, reduced repair cost, supplier involvement in new product design
	Service	q3's education/ training program of quality for its supplier, joint quality and productivity team, quantitative supplier evaluation program	Reduced number of suppliers
Vera, D.D. et al (1988). Quality Progress; Case study	Manufacturing	QFD	Reduced final product price by 50%, reduced engineering expense by 50%, reduced drafting expense by 20%

Table 2-7. Proposed Tools/Joint Practices-Industry Type Combinations

(Numbers in parentheses in the first and second columns indicate the number of the same industry type and frequency of joint practices identified in Table 2-6 respectively.)

Industry type	Tools/joint practices used
Manufacturing (12)	QFD (2), JIT delivery and purchasing (2), Supplier evaluation (2) and qualification (1), Long-term commitment to partner relationship (2), Joint problem-solving (1) and goal-setting (1), Quality education and training (1), Incentive system (1)
Service (5)	Joint action team or committee (3), QFD (1), Education and training (1), Supplier certification (1) and evaluation (1), A team of multiple suppliers (1)
Overall (Manufacturing + Service)	QFD (1), JIT (1)

specificity provides the user with (semi-) standardized ways to apply the tools to their q1-q3 relationships. On the other hand, the service industry is likely to use other practices that do not provide standardized or fixed ways to use, such as the joint action committee. Unlike the three tools mentioned above, a form of joint action committee involves not only the technical aspects of interactions, but also social, cultural, and any other human related aspects.

Second, based partly on the first trend, the performance results achieved from tools used by manufacturing industries are different from those of the service industry. That is, performance measures and results used and obtained in the manufacturing industry are more specific and concrete than those used in the service industry. This may be explained by the different natures of the joint action used by the two industries. The tools more likely used in the manufacturing industry usually provide performance measures and subsequent results that can be easily quantified, such as increase/decrease in production cost/selling price, gains and losses expressed in percentages and rates, and so on. On the other hand, the service industry uses performance measures such as an increased ability to meet the customer's expectations, a prolonged contract period, a multiyear partnership, and so on.

Table 2-8. Frequently Used Performance Dimensions

Performance dimensions	Specific performance results used in Table 2-6
Quality	q1's improved quality and reduced defect rate; q3's improved quality of final product (Chen & Batson) Higher quality of q1's service (Cross) Improved quality of supplier's operations (processes), improved quality of incoming purchased items (Graham et al.) Overall field return rate (17%), re-return rate (14%), no trouble found rate (19%) (Johnson) q3's rework reduced by 24%, scrap rate reduced by 21%; q1's quality improved by 26% (Raia) Supplier's improved quality (Schonberger & Ansari)
Cost	q3's reduced inspection cost of outgoing products (Chen & Batson) Sharing of cost savings (Cross) Decreased supplier's/customer's total cost (Graham et al.) WIP inventory reduced by 31%, costs reduced by 11% (Raia) Reduced repair cost (Morgan and Zimmerman) Reduced engineering expense by 50% and reduced drafting expense by 20% (Vera et al.)
Cycle time	Lead-time reduced by 29% (Raia) Reduced lead-time cost (Morgan and Zimmerman)
Others	Reduced product price (Hauser; Vera et al.) Use of SPC tools (Chen & Batson) Increased productivity by 7.5% (Stuart and Muller; Vera et al.)

Third, three specific performance dimensions are identified as the most-widely used indicators of measuring the impact of tools and joint practices: quality, cost, and cycle time. Table 2-8 shows these three performance dimensions and others used at least once.

This chapter introduced quality experts' perspectives on key issues on upstream management systems, followed by specific research findings relevant to the q1-q3 joint action and shared results. The next chapter describes data collection and analysis strategies as well as specific operational measures of variables introduced in Chapter 1.

CHAPTER 3. RESEARCH METHODOLOGY

The purpose of this chapter is to describe the methodology used in this research, including data collection instruments, operationalization of variables, data collection procedures and sampling, and data analysis procedures. In Sections 3.1 and 3.2, the type and value of this research, and some characteristics of non-experimental research are described. Sections 3.3-3.5 describe the use of the mailed survey questionnaire and structured interviews as the two primary research methods – development of data collection instruments, pilot study, administering the mailed survey questionnaire and structured interviews (data collection), and assessment of reliability and validity. Section 3.6 describes data analysis procedures to address the research questions.

3.1   *About This Research (Type and Value)*

In section 3.1.1, the type of this research is described using three different categories: inductive, descriptive, and applied research characteristics. Then, the value of conducting this research is described in Section 3.1.2 using Sternberg's (1981) three questions.

3.1.1   The type of research

Based on the research purpose/objectives and questions addressed in Chapter 1, this research has three characteristics. First, this research is inductive because it primarily deals with two sources of data – data from a mailed survey questionnaire and structured interviews with practitioners – to derive conclusions about q1-q3 partnerships in terms of the level of their joint action and the shared results of the joint action. These data were the basis for the construction of major outcomes and new assertions on the level of the four proposed shared results of q1-q3 joint action. Data were statistically analyzed and organized to produce quantitative findings which became the basis of theoretical assertions

(i.e., hypothesis testing) on q1-q3 joint action and shared results. Also data from the structured interviews, most of which were qualitative, were used to support and illuminate the results derived from the mailed survey questionnaire findings. Then, conclusions from results were drawn and generalized to the extent possible. Therefore, this research is inductive, rather than deductive.

Second, this research is also descriptive because it is devoted to the description of the level of q1-q3 partnerships through their joint action and shared results. The descriptive research method is appropriate for data derived from simple observational situations similar to the mailed survey questionnaire and interview. Although the descriptive research method relies on observation for collecting data, those data must be organized and presented systematically, so that valid and accurate information and knowledge can be drawn from them.

Third, this research is also applied research. Unlike basic research in which knowledge is the primary end in itself and the researchers' major interest is in discovering the central factors (or truth) in a problem (Goode & Hatt, 1952; Patton, 1990), this research uses past and present theories and assertions on q1-q3 relationships to study current upstream management practices. Sharing these findings will help other researchers and practitioners clarify the roles and scope of upstream management, especially q1-q3 joint action, and also, extend body of knowledge on q1-q3 joint action.

3.1.2   The value of the research

The value of research in general, including this research, can be explained by answering Sternberg's (1981) three questions:

Is the research doable (researchable)?   The answer depends on whether or not relevant texts or data are available/accessible. There were several sources of data for this research: for the mailed survey questionnaire, *Directory of Corporate Affiliations* (1996) and members of American Society for Quality Customer- Supplier Division (ASQ-CSD) were used. Other similar sources of data include (1) managers of purchasing and marketing departments of member companies of many associations such as NAPM

(National Association of Purchasing Management) and AMA (American Manufacturing Association), (2) industry index (e.g., *Funk and Scott's Index of Corporate Change*, *Standard & Poor's Register of Corporations*, *etc*.). For the interviews, managers were selected who are responsible for buying, selling, and operations/production functions of the companies. For this study, managers in the above mentioned functions of companies who won the Virginia's *Senate Productivity and Quality Award (SPQA)* in 1990-1996 and members of NAPM and ASQ-CSD (Roanoke-Radford section) were used.

       Does the research make a contribution to the field? Only a few large organizations have successfully documented and applied joint action to their upstream systems and managed their relationships with the supplier as shown in some exemplary cases of Chapter 2. In this research, a detailed description of organizational upstream management practices was provided in two ways. Statistically, the current level of q3 (q1) organizations' willingness to share the results of their joint action with the supplier (customer) was identified. And practically, joint action used to help q1 and q3 organizations and their managers improve the downstream and upstream effectiveness respectively so they can proactively seek to act jointly with the partner and to share the results of the joint action was explored.

       Is this research original? As was mentioned, there have been many researchers who have examined the key factors of q1-q3 partner relationships. However, there is little, if any, research about the results of q1-q3 partnerships. In this study, performance measures were embedded within the four dimensions – role integrity, conflict resolution, flexibility, and mutuality – so that each measure could be measured and analyzed. In addition, perceptual performance measures were included in this research to assess outcomes of joint action.

3.2   *Research Design*

       This study utilizes non-experimental research design, with the main purpose of seeking explanations of the relationships between independent (q1-q3 joint action) and dependent (shared results) variables. A non-experimental research design is a systematic

empirical inquiry in which the researcher does not have direct control of independent variables because their manifestations have already occurred or because they are inherently not manipulable (Kerlinger, 1986). In this research, there was neither an attempt to manipulate independent variables (q1-q3 joint action) nor make random assignments of research subjects as would be found in experimental research.

Although the inference of causality between independent and dependent variables was limited because independent variables were not manipulated, this research attempted to generalize findings from a mailed survey questionnaire and structured interviews to the extent possible. The generalization of findings is different from the purpose of predictive research, such as experiments, where the researcher's primary interest is in causal relationships between predictor and criterion variables where the variance in the latter caused by the variance in the former is explained. Using real world q1-q3 relationships in a non-experimental design, this research took advantage of involving as many participants as possible, given resource constraints.

To achieve the purpose, this research defined three different sets of variables: exogenous variables – four key factors of q1-q3 partnerships (commitment to long-term relationships, trust, communication, and specific investment) not measured or studied in this research; latent exogenous variables (or independent variables) – q1-q3 joint action (joint use of specific tools and joint practices); and latent endogenous variables (or dependent variables) – shared results of q1-q3 joint action (role integrity, conflict resolution, flexibility, and mutuality). (See Figure 3-1: Conceptual Research Model that is reproduced from Chapter 1.) Although this research began with a set of four exogenous variables in developing a model, only two sets of variables – latent exogenous variables (independent) and latent endogenous (dependent) variables – and their relationships were the main foci, using carefully designed mailed survey questionnaire and interview instruments. In addition, another set of variables not studied in this research, intervening variables, is shown in Figure 3-1.
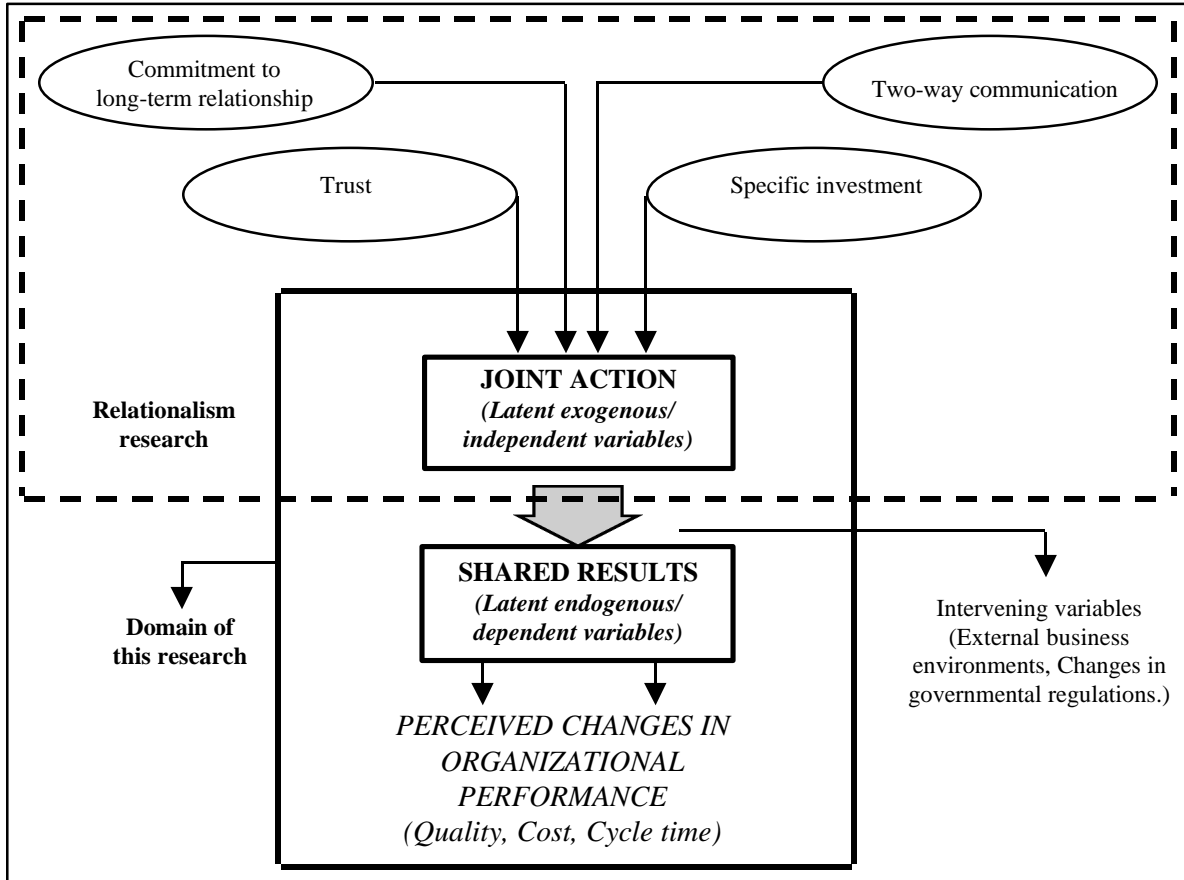
Figure 3-1. Conceptual Research Model (Reproduced)

3.3   *Development of Data Collection Instruments*

Two inquiry research methods were used in this research – the mailed survey
questionnaire and the structured interview. Among many data collection methods, such as
observation, interview, reviewing archival documents, or any combination of the three, the
two methods selected for this research have been predominantly used by many social and
behavioral researchers and scientists. For example, many relationalism studies on which
the major variables of this research are based used either survey questionnaires or
interviews, or both, to examine the relationships among key factors of q1-q3 partnerships
(Boyle et al., 1992; Dant & Schul, 1992; Guetzkow, 1966; Heide & John, 1992;
Kaufmann & Dant, 1992; and Laumann, Galaskiewicz, & Marsden, 1978).

The primary purpose of using these two research methods was to utilize an overall strategy where the two methods complement each other. Because the two methods are different – the mailed survey questionnaire is one of the most frequently used methods by researchers in positivism, while the (structured) interview is one of the methods used by phenomenologists – there are advantages and disadvantages associated with using each method alone.

The following sections focuses predominantly on the development of the mailed survey questionnaire, but also include the process of developing and executing structured interviews.

3.3.1 Mailed survey questionnaire

The purpose of the mailed survey questionnaire used in this research was to collect quantitative data for statistical analysis. To test the proposed hypotheses, it was necessary to collect the appropriate amount of quantitative data from which conclusions could be reached concerning the relationships between independent and dependent variables. To develop the mailed survey questionnaire, the general guidelines in Figure 3-2 were followed, and more detailed information about how each step in Figure 3-2 was conducted is explained in each of the following sections.

The steps and techniques in Figure 3-2 were developed based on the following sources: Churchill (1979), DeVellis (1993), Dunn et al. (1994), Hayes (1994), Larson & Sinha (1995), Tabladillo & Canfield (1994), and Tamimi, Gershon, & Currall (1995).

3.3.1.1 Specify domain of constructs

The first suggested step for developing effective measures using a mailed survey questionnaire involves specifying the domain of the construct. For this research, major constructs – joint action and the four shared result measures – were defined based on previous literature in relationalism, which are summarized in Table 3-1.

3.3.1.2 *Generate sample of items*

The second step shown in Figure 3-2 is to generate items which measure or capture the domain as specified. Some example techniques for generating items are also shown in Figure 3-2. For the mailed survey questionnaire items used in this research,

Suggested	**Recommended Techniques and Action**
1. Specify domain of constructs (Section 3.3.1.1)	- Literature search - Generate operational definitions of constructs (and sub-constructs)
2. Generate sample of items and pilot study (Sections 3.3.1.2 and 3.3.2)	- Literature search - Content Validity - Focus group interviews
3. Administer the survey to research sample (Section 3.4)	- Collect data from target sample - Probability/non-probability sampling - Tips for higher response rate and better quality results
4. Assess reliability and validity (Section 3.5)	- Reliability (internal-consistency) - Construct validity (factor analysis)
5. Data analysis (Section 3.6) and theory/norm testing/development	

Figure 3-2. Suggested Steps for Developing Effective Measures

Table 3-1. Constructs Used in This Research

Constructs	Conceptual Definition	Adapted from
Independent Variable Joint Action	Inter-penetration of organizational boundaries.	Guetzkow, 1966; Laumann, Galaskiewicz, & Marsden, 1978
Dependent variables Shared results from the joint action - Role integrity	The extent to which parties maintain highly complex and multi-dimensional roles in terms of duration, extent of specific transaction, and range of obligations.	Kaufmann & Dant, 1992
- Conflict resolution	Internal and informal mechanisms (procedures/ processes/activities) to resolve any problems that arise in the transactional and relational exchanges between the two organizations, smoothly and more favorably to each other.	Dant & Schul, 1992; Kaufmann & Dant, 1992
- Flexibility	A bilateral expectation of willingness to make adaptations as operating environments change.	Heide & John, 1992
- Mutuality	In relational terms, mutuality refers to a requirement of a positive incentive to cooperate with the partner. It also refers to equity in the distribution of surpluses and burdens (or benefits and expenses) over the long-term business transactional horizon.	Boyle et al., 1992

three sub-steps below were followed before the final mailed survey questionnaire was developed.

1. *Initial mailed survey questionnaire development*: Using the constructs shown in Table 3-1, the mailed survey questionnaire was developed by the researcher based on previous research activities: readings and observation of literature on q1-q3 partnerships in disciplines such as marketing, purchasing, and industrial engineering. However, most items developed in this step were not directly adopted from the previous literature on q1-q3 partnerships. This is because the constructs previously used by other researchers were treated differently (i.e., many researchers in relationalism treated shared result measures separately or as a combination of the four measures as dependent variables of critical

factors of q1-q3 joint action – commitment, communication, trust, and specific investment). Another reason is that the focus and objectives of previous q1-q3 partnership research are different from this research. Therefore significant changes were made to those items adopted from the previous literature although the basic idea came from the original items in the previous research in Table 3-1. Table 3-2 shows measurement and data collection methods for the mailed survey questionnaire items. These items were pilot tested, and changes were made as indicated by pilot study results (described in Appendix D) such that the actual survey items used in the research sample are not identical to those in Table 3-2.

Table 3-2. Measurement and Data Collection Methods for Initial Mailed Survey Questionnaire[I] (Prior to Pilot Test)

Variables and indicators	Operationalization of indicators and item(s)	Level of measure-ment	Number of items (and item number(s))
Organizations			
- Partner	Single vs. multiple sources for certain items	Nominal	1 (Part I-# IV)
- Organizational tenure	Number of years with the partner	Ratio	1 (Part I- # VII)
- Amount of business with the partner	% amount of sales to/purchasing from the partner	Ratio	1 (Part I-# VIII)
- Total annual sales volume	Average total sales volume of the company	Nominal	1 (Part I-# IX)
Individual demographics			
- Status	Customer (buyer) vs. supplier (seller)	Nominal	1 (Part I-# 1)
- Sex	Male vs. Female	Nominal	1 (Part I-# III)
- Job tenure	Number of years or months of experience with this job	Ratio	1 (Part I-# V)
- Organization tenure	Number of years or months of experience with this organization	Ratio	1 (Part I-# VI)

I: The final version full mailed survey questionnaire is shown in the Appendix C.

Table 3-2. Measurement and Data Collection Methods for Initial Mailed Survey Questionnaire (cont.)

Variables and indicators	Operationalization of indicators	Level of measurement[II]	Number of items (and item number(s))
q1-q3 joint action	Inter-penetration of organizational boundaries by:		
- Joint use of tools	Joint implementation and deployment of specific and already-existing TQM tools (**TQMT**) 1. We are using specific tools with our partner to jointly design new products. 11. People in the two companies use mechanisms or tools to design better quality systems. 15. The relationship with our partner involves the use of quality tools for longer term planning.	Ordinal	3 (Part II-# 1, 11, 15)
- Joint practices	Personal contacts for joint planning, problem-solving, and exchange of strategic information without using specific TQM tools (**PRAC**) 7. Our partner is involved in joint planning activities with us that traditionally were considered only one party's responsibility. 8. In the relationship with our partner, there is an exchange of strategic information, such as cost and price structure. 22. The relationship with our partner includes formal evaluation and assessment. 23. In our relationship, the responsibility for certain tasks has always been assigned to one *or* the other party. 31. The relationship with our partner involves frequent personal contacts for exchange of ideas and information. 35. We are willing to put aside contract terms in order to jointly work through difficult technical or quality problems that arise. 44. The relationship could be described as a 'long-term joint venture' or partnership.	Ordinal	7 (Part II-# 7, 8, 22, 23, 31, 35, 44)
Shared results	Level of complexity and multi-dimensionality of roles:		
- Role integrity	- With financial impact (**RIW**) 9. We have made financial investments in our company, such as tooling, equipment, and training employees, dedicated to the relationship with our partner. 12. If our relationship with our partner were discontinued, our sales would suffer. 16. My company, when appropriate, invests money in our partner's facilities and equipment. 24. Our partner shares information to help our company increase quality and productivity. 38. We provide each other with technical support in substantial detail. 41. Our partner makes an effort to help us during financial emergencies, for example, deferring payments or paying in advance. 43. Our partner helps us identify cost reduction opportunities.	Ordinal	7 (Part II-# 9, 12, 16, 24, 38, 41, 43)

II: All ordinal scales are 6 point scales: 1 - Strongly disagree, 2 - Disagree, 3 - Somewhat Disagree, 4 - Mildly agree, 5 - Agree, and 6 - Strongly agree.

Variables and indicators	Operationalization of indicators	Level of measure-ment[II]	Number of items (and item number(s))
- Role integrity	- Without financial impact (**RIWO**) 4. Both parties share information on performance in meeting the expectations and needs of the other. 10. Our partner offers specific suggestions to help us improve our processes and procedures. 13. Our partner is responsive in maintaining a cooperative relationship with us. 17. From time to time, we are willing to make sacrifices to help our partner. 25. Both parties have multi-dimensional roles that go beyond the mere buying and selling of products. 26. The relationship with our partner includes diverse expectations over many issues. 36. We keep each other informed about events or changes that may affect the other party. 39. We regularly provide our partner with long-range forecasts of supply capabilities or demand requirements. 40. We are responsive in maintaining a cooperative relationship with our partner.	Ordinal	9 (Part II-# 4, 10, 13, 17, 25, 26, 36, 39, 40)
- Conflict resolution	Level of internality and informality of mechanisms to solve problems (**CR**) 3. Our procedures for dealing with disputes in the relationship with the partner are informal. 18. Problems that arise in the course of this relationship are treated as *joint* rather than *individual* responsibilities. 27. Each conflict is treated as a further improvement opportunity. 30. Neither party abuses its power over the other party. 37. Rather than relying on legal procedures to resolve conflicts (i.e., filing a suit), both parties rely on more informal means. 42. Temporary setbacks in our partner's performance commitment are accepted and resolved in an aligned and negotiated way.	Ordinal	6 (Part II-# 3, 18, 27, 30, 37, 42)
- Flexibility	Level of bilateral expectation of willingness to make adaptation (**FLEX**) 6. The procedures and routines developed by our partner are adapted to our particular situation. 21. Changes in the terms of ongoing transactions with our partner are made if unanticipated economic events occur. 29. The relationship with our partner can be characterized as flexible. 32. Our partner is flexible in response to requests we make.	Ordinal	4 (Part II-# 6, 21, 29, 32)

II: All ordinal scales are 6 point scales: 1 - Strongly disagree, 2 - Disagree, 3 - Somewhat Disagree, 4 - Mildly agree, 5 - Agree, and 6 - Strongly agree.

Table 3-2. Measurement and Data Collection Methods for Initial Mailed Survey Questionnaire (cont.)

Variables and indicators	Operationalization of indicators	Level of measurement[II]	Number of items (and item number(s))
- Mutuality	Level of positive incentives to cooperate with the partner and equity in the distribution of surpluses and burdens in the long-term		
	- With short-term and direct financial impact (**MUW**)	Ordinal	6 (Part II-# 2, 5, 19, 20, 28, 33)
	2. Any concessions we make to help our partner will even out in the long run. 5. The benefits my company realizes from this relationship are proportional to the efforts put forth. 19. Our company gets a fair share of the financial rewards and cost savings from the relationship with our partner. 20. Benefits from problem solving with our partner are shared jointly. 28. If our partner helps us reduce our costs, the partner also benefits. 33. Our partner emphasizes what they will offer in return for our cooperation or participation.		
	- Without short-term and direct financial impact (**MUWO**)	Ordinal	2 (Part II-# 14 and 34)
	14. Both parties are committed to improvement that benefits the relationship as a whole, not just the individual parties. 34. There is a strong spirit of fairness in the relationship with our partner.		
- Specific tools/practices and their effectiveness	45. The next set of questions consists of two steps each. *First*, check (√) the tool or joint practice you are currently using in your relationship with your partner. And *second*, indicate the overall effectiveness of each tool or joint practice you checked by circling appropriate number. 46. If there are other tools or joint practices you and your partner are using that were not listed in the previous question, please list them below. (See Appendix C for full version items.)	Nominal and ordinal	2 (Part III-# 45 and 46)
- Perceived performance changes	47. *First*, identify the impact of using tools or joint practices by specifying a *percentage increase* or *decrease*. *Second*, identify only tools/practices that are predominantly responsible for the percentage increase/decrease in quality, cost, cycle time, and other performance dimensions. 48. Based on all the tools/joint practices you identified in Questions #45 & 46, what is the **overall** effect on organizational performance?	Ratio and nominal	2 (Part III-# 47 and 48)
- Satisfaction level with the partner	47. Overall, my level of satisfaction with this partner is very high.	Ordinal	1 (Part III-# 49)
- Quality of partnership	48. Overall, the quality of the partnership with this partner is very high.	Ordinal	1 (Part III-# 50)

II: All ordinal scales are 6 point scales: 1 - Strongly disagree, 2 - Disagree, 3 - Somewhat Disagree, 4 - Mildly agree, 5 - Agree, and 6 - Strongly agree.

2. *Pilot study*: The pilot study was conducted using 46 managers of previous SPQA applicant companies for their feedback on the appropriateness of each item of the mailed survey questionnaire. A 21.7% response rate (10/46) was obtained and summary results are shown in Figure 3-3. Although the reliability coefficients of most constructs are relatively high, one construct – CR (conflict resolution) – does not meet the generally accepted internal-consistency range: .70 in general and 0.6 or 0.5 for exploratory work involving the use of newly developed scales (Nunnally, 1978). This may be caused by some deficiencies associated with newly developed items, as in this research. To examine why the reliability coefficient of CR was too low, correlation coefficients of items in CR were calculated. As shown in Appendix D, some correlation coefficients were very low, such as 0.15 between the first and second items and 0.12 between the fourth and sixth items, and 0.14 between the fifth and seventh items. To overcome this low reliability coefficient problem and to develop better items with higher reliability and validity, continuous revisions were made to increase face and content validity, including revisions made based on a focus group interview. (See Appendix D for detailed pilot study results.)

3. *Focus group interview*: There were two purposes for the focus group interview as used in this research. The first was to gain a better appreciation for the practitioner's perspectives on q1-q3 partnerships, especially q1-q3 joint action and shared results, and second, to improve the overall quality of the mailed survey questionnaire initially developed by the researcher. The interview guide used in the focus group interview is found in Appendix C. The steps and questions in Appendix C were designed based on general guidelines by Krueger (1994). The intent of the focus group interview was to promote self-disclosure among participants by providing them with an environment to discuss and share ideas. This intent could be further ensured by the moderator's skillful probing to make discussions comfortable and enjoyable when participants share their ideas and perceptions about the focus group topic (Krueger, 1994). Three ASQ Radford-Roanoke Chapter members participated in the focus group interview (February 12th, 1997;

Virginia Tech Continuing Education Center). See Appendix D for summary results from the focus group interview.

Pearson Correlation Coefficients

	TQMT	PRAC	RIW	RIWO	CR	FLEX	MUW	MUWO
TQMT	1.000							
PRAC	.8817	1.000						
RIW	.8318	.7396	1.000					
RIWO	.8934	.9539	.6458	1.000				
CR	.7891	.6798	.5896	.7665	1.000			
FLEX	.6171	.7099	.3780	.7683	.3524	1.000		
MUW	.6691	.7637	.3702	.8530	.5530	.7444	1.000	
MUWO	.6580	.8055	.3835	.8663	.7032	.5874	.9302	1.000

Simple Statistics

Variable	Mean	Std Dev	Minimum	Maximum
TQMT	4.850000	0.826640	3.500000	5.750000
PRAC	4.300000	0.627556	3.500000	5.333333
RIW	4.233333	0.577231	3.000000	4.888889
RIWO	4.780000	0.676264	3.700000	5.800000
CR	4.514286	0.447720	4.000000	5.285714
FLEX	4.660000	0.607728	3.800000	5.900000
MUW	4.550000	0.950512	2.250000	5.625000
MUWO	4.850000	1.179689	2.000000	6.000000

Internal-consistency Reliability (α)

ALPHA-TQMT:	0.6300813	ALPHA-PRAC:	0.6008359
ALPHA-RIW:	0.6587073	ALPHA-RIWO:	0.8870532
ALPHA-CR:	0.0955254[II]	ALPHA-FLEX:	0.8637518
ALPHA-MUW:	0.9300538	ALPHA-MUWO:	0.5322688

Figure 3-3. Summary Results[I] of the Pilot Study with SPQA Companies

I: Summary results in Figure 3-3 were generated from SAS/PC. See Appendix D for detailed results.
II: See Appendix D for correlations among items in this indicator (conflict resolution) and subsequent changes made in the mailed survey questionnaire.

3.3.2   Structured interview

In addition to the mailed survey questionnaire developed as described in Section 3.3.1, structured interviews were used to complement the mailed survey using qualitative

data. Appendix C contains the interview guide (interviewer questions). The structured interview guide was developed based on the focus group interview guide and contains some other questions that were used to develop a profile of interviewees (# 1-3) and to derive more general qualitative data (# 20-21).

To pilot test the interview guide, three preliminary interviews were conducted with 2 NAPM members and one ASQ member in the Roanoke-Radford section. Each interview lasted 50-60 minutes. Appendix D shows summary results from the pilot structured interviews.

Based on findings from the pilot study, the focus group interview, and pilot structured interviews, changes were made in the initial survey and the final set of items used in the mailed survey questionnaire administered to the research sample (shown in Table 3-7). (See Appendix D for a detailed list of changes made between the initial survey items in Table 3-2 and the final survey items in Table 3-7.)

3.4   *Data Collection Procedures*

This section corresponds to the third step of Figure 3-2, and includes sampling strategies and data collection procedures for the mailed survey questionnaire and structured interviews.

3.4.1   Sampling strategy for the mailed survey questionnaire

Because one of the major objectives of this study was to draw generalizable conclusions to the extent possible, ideal data would be drawn from the total population[1]. To obtain this objective with limited resources in terms of access, time, and funding, the following five sample selection criteria were used:

1. Industry type and ownership – private manufacturing;
2. Geographic location – U.S.-based;
3. Number of participants –1,811 potential respondents;
4. Industry scope – SIC 35, 36, and 37; and

---

[1] Note that, in this research, (1) the total population is U.S. private manufacturing companies registered in the *Directory of Corporate Affiliation* under the category of SIC 35, 36, and 37 in 1996 and (2) the sampling frame is companies (or individuals) to whom the mailed survey questionnaire was actually sent.

5. Nature of participants − partnerships.

The first criterion indicates that this study sampled only privately-owned manufacturing companies. The second criterion specifies limiting the research scope to U.S.-based firms. One of the reasons for focusing on U.S.-based companies was to reduce the amount of variation that would be derived from the research data if q1-q3 partnerships of different and multi-cultural backgrounds were studied. In other words, if the targeted sources of research data included the United States' and other Eastern country's, e.g., Korea's or Japan's, q1-q3 relationships, the final results of this study would be different from the results derived from using only U.S.-based companies. This is because of the differences in cultural environments and historical backgrounds, especially in the areas of economic and industrial development.

The third criterion indicates that this study used 1,811 individuals as potential mailed survey questionnaire participants. This required sample size was determined from guidelines on the sample size needed given the number of variables studied. Given the number of variables studied and the expected response rata of 10-20% based on previous studies in relationalism, the sample frame needed was more than 1,000.

The last two criteria imply that this research used companies specializing in certain types of industries: SIC (Standard Industrial Classification) 35, 36, and 37, and in partnership. The three groups of industries are:

> SIC 35: Industrial equipment and machinery
> SIC 36: Electronic and electric equipment
> SIC 37: Transportation equipment.

Compared to other industries, such as agriculture (SIC 01-09), construction (SIC 15-17), wholesale trade (SIC 50-51), services (SIC 70-89), and public administration (SIC 91-97), the companies in SIC 35, 36, and 37 are characterized by more business related operational and personal contacts between q1 and q3. In other words, the q1 and q3 companies in the three SIC groups are more likely to build partnerships than are companies in other SIC groups.

Two sources were used to sample potential respondents of the mailed survey questionnaire: (1) 999 managers from the *Directory of Corporate Affiliations* (1996) and (2) all 812 ASQ Customer-Supplier Division (CSD) members who work in companies that are listed in SIC 35, 36, and 37 category. For the 999 managers (each of 333 managers of buying, selling, and operations/production functions) from the *Directory of Corporate Affiliations*, a stratified sampling method was used. The whole population from the directory that falls into the first, second, and fourth of the five sample selection criteria mentioned above was already divided into smaller subdivisions on the basis of four-digit SICs. This is because all the companies in the directory are organized by the four-digit SICs. For example, all U.S.-based private manufacturing companies in SIC 35 are further divided as follows:

    3511: Steam, gas, and hydraulic turbines; turbine generator set units
    3519: Internal combustion engines
    3523: Farm Machinery and equipment
                    :
    3594: Fluid power pumps and motors
    3596: Scales & balances, except laboratory
    3599: Industrial and commercial machinery and equipment.

Therefore, the researcher needed to randomly select only a certain number of specific four-digit SICs and include all companies in the selected SICs in the sample. (See Table 3-3 for actual four-digit categories selected.) The other companies in SIC 36 and 37 were also divided in the same way on the basis of the guidelines of the U.S. commercial department. Actual four-digit SICs used for this purpose are shown in Table 3-3. The intent in stratified sampling was to reduce sampling variability by creating a relatively homogeneous strata (Pedhazur & Schmelkin, 1991). To meet the fifth category – partnerships – the mailed survey questionnaire instrument asked the potential respondents to choose only one company that they would consider their company's partner before answering the mailed survey questionnaire questions.

Table 3-3. Four-Digit Company SICs and Type of Industries Actually Used

SIC 35:Industrial equipment and machinery [Total sampled: 336]	SIC 36: Electronic and electric equipment [Total sampled: 297]	SIC 37: Transportation equipment [Total sampled: 366]]
3519: Internal combustion engines **3531**: Construction machinery & equipment **3544**: Special dies & tools, die sets, jigs & fixtures & industrial molds **3545**: Cutting tools, machine tool accessories & machinists precision measuring devices **3548**: Electric & gas welding & soldering equipment **3562**: Ball and roller bearing **3565**: Packaging machinery **3568**: Mechanical power transmission equipment **3577**: Computer peripheral equipment **3585**: Air conditioning & warm air heating equipment & commercial & industrial refrigeration equipment **3586**: Measuring & dispensing pumps **3592**: Carburetors, pistons, piston rings & valves **3593**: Fluid power cylinders & actuators	**3621**: Motor & generators **3624**: Carbon & graphite products **3625**: Relays & industrial controls **3629**: Electrical industrial apparatus **3631**: Household cooking equipment **3634**: Electric housewares and fans **3635**: Household vacuum cleaners **3639**: Household appliances **3643**: Current-carrying devices **3644**: Noncurrent-carrying wiring devices **3645**: Residential electric lighting fixtures **3646**: Commercial, industrial & institutional electric lighting fixtures **3647**: Vehicular lighting equipment **3648**: Lighting equipment **3651**: Household audio & video equipment **3652**: Phonographic records & pre-recorded audio tapes & discs **3661**: Telephone & telegraph apparatus **3663**: Radio & television broadcasting & communications equipment **3669**: Communications equipment **3672**: Printed circuit boards **3674**: Semiconductors & related devices **3675**: Electronic capacitors **3676**: Electronic resistors **3677**: Electronic coils, transformers & other inductors .**3678**: Electronic connectors **3679**: Electronic components **3691**: Storage batteries **3694**: Electrical equipment for internal combustion engines **3695**: Magnetic & optical recording media **3699**: Electrical machinery, equipment & supplies	**3711:** Motor vehicles & passenger car bodies **3713:** Truck & bus bodies **3714**: Motor vehicle parts & accessories **3715**: Truck trailers **3721**: Aircraft **3724**: Aircraft engines & engine parts **3728**: Aircraft parts & auxiliary equipment **3731**: Ship building & repairing **3732**: Boat building and repairing **3743**: Railroad equipment **3751**: Motorcycles, bicycles & parts **3764**: Guided missile & space vehicle propulsion units & propulsion unit parts **3769**: Guided missile & space vehicle parts & auxiliary equipment **3792**: Travel trailers & campers **3799**: Transportation equipment

For the 812 ASQ-CSD members, the researcher contacted the chair of the division. Eight hundred and twelve members' names and addresses falling into the first, second, and fourth sampling categories were provided by the ASQ headquarters.

3.4.2 Sampling strategy for the structured interviews

For the structured interviews, companies meeting the same criteria – U.S.-based private manufacturing companies in q1-q3 relationships – were used. For both easy

access due to geographic locations and high quality data, companies that have recently (1990-1996) won the Commonwealth of Virginia's *Senate Productivity and Quality Award* (SPQA) in the Private Sector Manufacturing category and members of NAPM and ASQ in the Roanoke-Radford section were used. The companies selected for the structured interview, especially SPQA winners, have been evaluated as effective in their upstream management practices because one of the decision criteria for the SPQA is *Customer and Supplier Involvement*.

3.4.3   Data collection procedures for the mailed survey questionnaire

There were two mailings to each of the two sources of potential mailed survey questionnaire respondents. The survey questionnaire was mailed to 999 managers whose names were taken from the directory in the first mailing. Although each company used different names for the above official positions, the mailed survey questionnaire, along with a cover (invitation) letter, instruction sheet, and Informed Consent Form, was delivered directly to individuals who were the most responsible for buying, selling, and operation-/production-related activities. In addition to this mailing strategy, the researcher asked the manager of purchasing and marketing to answer the mailed survey questionnaire from the customers' and suppliers' perspectives, respectively, not only to prevent the mailed survey questionnaire from being passed on to other unrelated persons, but also to obtain reliable and accurate data. It was, however, impossible to ask the manager of the operation-/production-related department to choose only one perspective. Therefore the researcher left the decision about which perspective they should take up to the manager of the operation-/production-related department to observe how many chose each of the two perspectives.

One week after the first mailing, a follow-up call (or fax or letter)/thank you letter was mailed to increase the overall response rate. First, a follow-up call/fax/letter, depending on availability, asking non-respondents to answer the mailed survey questionnaire was made/sent to all non-respondents. Second, a thank you-message was sent to all participants in the mailed survey questionnaire who had replied by the follow-up

stage. (Major milestones scheduled for this mailed survey questionnaire may differ from those introduced in books such as Bailey [1994], DeVellis [1991], and Dillman [1978]. There is no one recommended way of scheduling the mailed survey questionnaire administration that is agreed on and practiced by researchers. The major milestones prepared for this research were based on given resources such as time and funding.)

In the first mailing to the 812 ASQ-CSD members, the same procedures were followed and the same mailing contents were sent. In the follow-up, however, only a follow-up letter was sent to all non-respondents because their phone and fax numbers were not available. This is because a follow-up letter (vs. a follow-up call or fax) was agreed upon by the researcher and the chair of ASQ-CSD in order to protect members' privacy. Table 3-4 shows major milestones of survey administration.

Table 3-4. Major Milestones of Mailed Survey Administration

Date	Activity
June 11, 1997	Survey mailed out to 999 managers of U.S. private manufacturing companies (SIC 35, 36, and 37)
June 19-23, 1997	Follow-up call (or fax or letter)
June 30, 1997	Survey response deadline
July 28, 1997	Survey mailed out to 812 ASQ-CSD members (SIC 35, 36, and 37)
August 12-13, 1997	Follow-up letter
August 29, 1997	Survey response deadline

Using the procedures mentioned in this section, a total of 172 (overall response rate: 9.78%) usable surveys were returned. Table 3-5 shows summary statistics regarding this response rate.

3.4.4 Data collection procedures for the structured interviews

For the structured interview, managers of buying, selling, and operation-/production-related functions of target companies (SPQA winners in 1990-1996) and individuals (members of NAPM and ASQ in Roanoke-Radford Section) were contacted. A total of 7 managers were interviewed using the interview guide in Appendix C. Table

3-6 shows a brief profile of all 7 interviewees. (See Appendix E for summary results of structured interviews.)

Table 3-5. Survey Response Rate

	Non-ASQ-CSD	ASQ-CSD
Total # of surveys mailed out	999	812
Total # of surveys returned	61	122
# of undeliverable addresses	50	2
Unusable surveys (due to missing data)	6	5
# of usable surveys	55	117
Total response rate	61 / (999-50) = 6.43%	122 / (812-2) = 15.1%
Actual response rate	55 / (999-50) = 5.51%	117 / (812-2) = 14.4%
Overall response rate: (55+117) / (999+812-50-2) = 9.78%		

Table 3-6. Profile of Seven Interviewees

Date	Interviewee	Title	Company	Location	Perspective(s) taken
07/21/97	1. Michele Meyer (ASQ)	Training administrator	Federal Mogul	Blacksburg, VA	Customer & supplier
07/23/97	2. Donald Clark (SPQA)	Sr. Director, Purchasing	Canon Va, Inc.	Newport News, VA	Customer
07/25/97	3. Mike Mabry (NAPM)	Purchasing manager	Plymouth	Radford, VA	Customer
07/28/97	4. Brendon McSheehy (SPQA)	Director, R & D	Cookson Fibers, Inc.	Bristol, VA	Supplier
07/29/97	5. Kenneth Olszewski (NAPM)	Sourcing manager	Hubell Lighting	Chrstiansburg, VA	Customer
08/01/97	6. David Crites (NAPM)	Purchasing supervisors	AllianTech System	Radford, VA	Customer
08/29/97	7. Melvin Clark (ASQ)	Director, Purchasing	Stanley	Martinsville, VA	Customer

In addition to the interview guide, the interviewees were also asked to complete the mailed survey questionnaire. However, to avoid the tediousness that would be caused by asking all closed-ended items in the mailed survey questionnaire directly to the interviewee, the survey questionnaire was mailed to the interviewee a week before the

interview. Five out of 7 interviewees completed the mailed survey questionnaire. These five responses were not included in the reliability and validity assessment, or in data analysis, because the way the mailed survey questionnaire was administered was different and all five responses had missing data.

3.5 *Assess Reliability and Validity*

To determine the quality of the mailed survey items, two methods were used: (1) reliability analysis using Cronbach's alpha and (2) factor analysis. These two analysis methods were recommended by Virginia Tech's Statistical Consulting Center. Additionally, methods used in similar types of studies using survey questionnaire were adopted here (e.g., Flynn, Schroeder, and Sakakibara [1994]).

3.5.1 Reliability analysis

Reliability is the degree to which measurements are free from random errors (X_R). Mathematically, perfect reliability means $X_R = 0$. Thus, the primary purpose of a reliability assessment is to produce observed scores which approximate true scores as closely as possible. A highly reliable mailed survey questionnaire accurately measures the specified construct (Churchill, 1979). Generally, a reliability of 0.7 is a minimally acceptable level of reliability (Kerlinger, 1973), and 0.8 or greater is preferable, although Nunnally (1978) states that a lower reliability, such as 0.6 or even 0.5, is acceptable for newly developed items. For this study, Cronbach's internal-consistency reliability was used. Table 3-7 shows the results of reliability analysis. (α^*: Cronbach's coefficient alpha if item were deleted; α^{**}: Overall Cronbach's coefficient alpha.) Although some items, if deleted from the scale, would improve internal-consistency, they were not deleted in order to examine how items across scales related to each other.

Table 3-7. Operational Measures of Variables and Reliability Analysis

Variables and indicators	Operationalization of indicators and item(s)	α*	α**
Individual demographics			
Status (or Perspective)	Customer (buyer) or supplier (seller) [Part I-1]	--	--
Title	[Official title] of [Dept. or section or division] [Part I-2]	--	--
Job tenure	Number of years or months of experience with this job [Part I-3]	--	--
Organization tenure	Number of years or months of experience with this organization [Part I-4]	--	--
Business partnership tenure	Number of years or months of experience with this partner [Part I-5]	--	--
Organizations			
Total annual sales volume	Average total sales volume of the company [Part I-6]	--	--
Number of employees	Total number of employees [Part I-7]	--	--
Status of the company	Parent organization? [Part I-8]	--	--
Partner	Single vs. Multiple sources for certain items [Part I-9]	--	--
Amount of business with the partner	% amount of sales to/purchasing from the partner [Part I-10]	--	--
Number of partner company's employees	Total number of partner company's employees [Part I-11]	--	--
Proportion of partnerships	% of partnership with customers and supplier [Part I-12]	--	--
Joint use of tools [**TQMT**] Joint implementation and deployment of already existing tools	[TQMT1] 1. We are using specific tools with our partner to jointly design new products.	0.70	0.69
	[TQMT2] 11. People in the two companies use mechanisms or tools to design better quality systems.	0.52	
	[TQMT3] 15. The relationship with our partner involves the use of quality tools for longer term planning.	0.57	
Joint practices [**PRAC**] Personal contacts for joint planning, problem-solving, and exchange of strategic information without using specific TQM tools	[PRAC1] 7. Our partner is involved in joint planning activities with us that traditionally were considered only one party's responsibility.	0.53	0.60
	[PRAC2] 8. In the relationship with our partner, there is an exchange of strategic information, such as cost and price structure.	0.53	
	[PRAC3] 22. The relationship with our partner includes formal evaluation and assessment.	0.60	
	[PRAC4] 23. In our relationship, the responsibility for certain tasks has always been assigned to one _or_ the other party.	0.69	
	[PRAC5] 31. The relationship with our partner involves frequent personal contacts for exchange of ideas and information.	0.51	
	[PRAC6] 35. We are willing to put aside contract terms in order to jointly work through difficult technical or quality problems that arise.	0.56	
	[PRAC7] 44. The relationship could be described as a 'long-term joint venture' or partnership.	0.51	
Role integrity with financial impacts [**RIW**] Level of complexity and multi-dimensionality of roles	[RIW1] 9. We have made financial investments in our company, such as tooling, equipment, and training employees, dedicated to the relationship with our partner.	0.53	0.53
	[RIW2] 12. If our relationship with our partner were discontinued, our sales would suffer.	0.59	
	[RIW3] 16. My company, when appropriate, invests money in our partner's facilities and equipment.	0.52	
	[RIW4] 24. Our partner shares information to help our company increase quality and productivity.	0.42	
	[RIW5] 38. We provide each other with technical support in substantial detail.	0.43	
	[RIW6] 41. Our partner makes an effort to help us during financial emergencies, for example, deferring payments or paying in advance.	0.48	
	[RIW7] 43. Our partner helps us identify cost reduction opportunities.	0.47	

α*: Cronbach's coefficient alpha if item were deleted

α**: Overall Cronbach's coefficient alpha

Table 3-7. Operational Measures of Variables and Reliability Analysis (cont.)

Variables and indicators	Operationalization of indicators and item(s)	α^*	α^{**}
Role integrity without financial impacts [**RIWO**] Level of complexity and multi-dimensionality of roles	[RIWO1] 4. Both parties share information on performance in meeting the expectations and needs of the other.	0.74	0.76
	[RIWO2] 10. Our partner offers specific suggestions to help us improve our processes and procedures.	0.75	
	[RIWO3] 13. Our partner is responsive in maintaining a cooperative relationship with us.	0.74	
	[RIWO4] 17. From time to time, we are willing to make sacrifices to help our partner.	0.77	
	[RIWO5] 25. Both parties have multi-dimensional roles that go beyond the mere buying and selling of products.	0.72	
	[RIWO6] 26. The relationship with our partner includes diverse expectations over many issues.	0.73	
	[RIWO7] 36. We keep each other informed about events or changes that may affect the other party.	0.73	
	[RIWO8] 39. We regularly provide our partner with long-range forecasts of supply capabilities or demand requirements.	0.73	
	[RIWO9] 40. We are responsive in maintaining a cooperative relationship with our partner.	0.72	
Conflict resolution [**CR**] Level of internality and informality of mechanisms to solve problems	[CR1] 3. Our procedures for dealing with disputes in the relationship with the partner are informal.	0.80	0.72
	[CR2] 18. Problems that arise in the course of this relationship are treated as *joint* rather than *individual* responsibilities.	0.63	
	[CR3] 27. Each conflict is treated as a further improvement opportunity.	0.68	
	[CR4] 30. Neither party abuses its power over the other party.	0.61	
	[CR5] 37. Rather than relying on legal procedures to resolve conflicts (i.e., filing a suit), both parties rely on more informal means.	0.67	
	[CR6] 42. Temporary setbacks in our partner's performance commitment are accepted and resolved in an aligned and negotiated way.	0.66	
Flexibility [**FLEX**] Level of bilateral expectation of willingness to make adaptation	[FLEX1] 6. The procedures and routines developed by our partner are adapted to our particular situation.	0.64	0.63
	[FLEX2] 21. Changes in the terms of ongoing transactions with our partner are made if unanticipated economic events occur.	0.70	
	[FLEX3] 29. The relationship with our partner can be characterized as flexible.	0.44	
	[FLEX4] 32. Our partner is flexible in response to requests we make.	0.41	
Mutuality with financial impacts [**MUW**] Level of positive incentives to cooperate with the partner and equity in the distribution of surpluses and burdens in the long-term	[MUW1] 2. Any concessions we make to help our partner will even out in the long run.	0.75	0.77
	[MUW2] 5. The benefits my company realizes from this relationship are proportional to the efforts put forth.	0.75	
	[MUW3] 19. Our company gets a fair share of the financial rewards and cost savings from the relationship with our partner.	0.69	
	[MUW4] 20. Benefits from problem solving with our partner are shared jointly.	0.71	
	[MUW5] 28. If our partner helps us reduce our costs, the partner also benefits.	0.79	
	[MUW6] 33. Our partner emphasizes what they will offer in return for our cooperation or participation.	0.74	
Mutuality without financial impacts [**MUWO**] Level of positive incentives to cooperate with the partner and equity in the distribution of surpluses and burdens in the long-term	[MUWO1] 14. Both parties are committed to improvement that benefits the relationship as a whole, not just the individual parties.	--	0.79
	[MUWO2] 34. There is a strong spirit of fairness in the relationship with our partner.	--	

α^*: Cronbach's coefficient alpha if item were deleted
α^{**}: Overall Cronbach's coefficient alpha

Table 3-7. Operational Measures of Variables and Reliability Analysis (cont.)

Variables and indicators	Operationalization of indicators and item(s)	α^*	α^{**}
Identification of tools/joint practices used and their effectiveness and internalization	45. *First*, check (√) only tools/practices your company is using jointly with your partner. *Second*, indicate the overall effectiveness of each tool or joint practice you checked by circling the appropriate number. And *third*, indicate whether or not each tool or joint practice you checked is internalized into the way you and your partner company do business by circling the appropriate number.	--	--
	46. Please list below any additional tools/practices not listed in Question #45 that you and your partner company are using jointly.	--	
Measuring perceived changes in organizational performance dimensions	47. *First*, identify the impact of using tools or joint practices by specifying a *percentage increase* or *decrease*. *Second*, identify only tools/practices that are predominantly responsible for the percentage increase/decrease in quality, cost, cycle time, and other performance dimensions.	--	--
	48. Based on all the tools/joint practices you identified in Questions #45 & 46, what is the **overall** effect on organizational performance?	--	
Level of satisfaction and quality of partnership	49.Overall, my level of satisfaction with this partner is very high.	--	--
	50.Overall, the quality of the partnership with this partner is very high.	--	

3.5.2   Factor analysis

Validity means having a conclusion correctly defined from the premises (Davis & Cosenza, 1985). In other words, it means the mailed survey questionnaire items measure what they are supposed to measure. A valid measure should yield correct estimates of what is being assessed: (1) the mailed survey questionnaire instrument is actually measuring the concept in question and (2) the concept is measured accurately. In other words, the first (1) without the second (2) is possible, but *not* vice versa. That is, the concept cannot be measured accurately if some other concept is being measured.

For this study, construct validity was assessed using factor analysis (DeVellis, 1991). Factor analysis was used because it determined whether the mailed survey questionnaire actually measures the concept in question. Factor analysis also indicates the number of underlying factors a set of items is measuring and which items are measuring which factors (Churchill, 1979). This section includes the four factor analyses resulting from combining conceptually similar constructs: joint use of specific tools (TQMT) and joint practices (PRAC), role integrity with (RIW) and without (RIWO) financial impacts, conflict resolution (CR) and flexibility (FLEX), and mutuality with (MUW) and without (MUWO) financial impacts. For the factor analyses shown below, [1] principal component factor extraction option, [2] prior communality of 1.0, and [3] promax rotation

option were used. These three options were used because they were recommended by faculty in the Virginia Tech Statistical Consulting Center.

3.5.2.1 First factor analysis (TQMT & PRAC)

Ten items (3 from joint use of specific tools, TQMT, and 7 from joint practices, PRAC) were entered into a factor analysis. The factor pattern matrix is shown in Table 3-8. (Factor loadings were multiplied by 100 and rounded to the nearest integer; Factor loadings less than 0.40 were suppressed.)

Table 3-8. Factor Pattern Matrix for Joint Use of Specific Tools (TQMT) and Joint Practices (PRAC)

	FACTOR1	FACTOR2	FACTOR3
TQMT1	73 *		
TQMT2	76 *		
TQMT3	73 *		
PRAC3	52 *		
PRAC6		78 *	
PRAC7		74 *	
PRAC5	45	70 *	
PRAC1	55 *		68
PRAC2		43 *	65
PRAC4			-59

Bolded items, also highlighted by *****, indicate which items were loaded onto which factors.

As shown in Table 3-8, four items (TQMT1, TQMT2, TQMT3, and PRAC3) loaded most strongly onto Factor 1, and three (PRAC6, PRAC7, and PRAC5) onto Factor 2. Internal consistency for these groupings was: α for Factor 1 = 0.67 and α for Factor 2 = 0.64. The alpha value for three items loaded onto Factor 3 (PRAC1, PRAC2, and PRAC4) was 0.32. Therefore the following actions were taken:

- No scale was constructed that related to Factor 3 because of low reliability.
- PRAC1 was switched to Factor1 because this item also loaded onto Factor 1 and the switching resulted in an increase in α for Factor 1 to 0.71 from 0.67.
- PRAC2 was switched to Factor 2 although this item loaded more strongly onto Factor 3 (which was not used). This caused an increase in α for Factor 2 to 0.65 from 0.64.

- PRAC4 was deleted and excluded from further analysis because this item loaded only onto Factor 3, whose α value was 0.32.

In summary, 5 items (TQMT1, TQMT2, TQMT3, PRAC1, and PRAC3) were retained in the construct TQMT and 4 items (PRAC2, PRAC5, PRAC6, and PRAC7) were retained in the PRAC construct. These were called 'joint use of tools' (TQMT; final α=0.71) and 'joint practices' (PRAC; final α=0.65), respectively.

3.5.2.2 Second factor analysis (RIW & RIWO)

The 7 items in role integrity with financial impact (RIW) and 9 items from role integrity without financial impact (RIWO) were entered into a factor analysis. Table 3-9 shows the factor pattern matrix.

Table 3-9. Factor Pattern Matrix for Role Integrity With (RIW) and Without (RIWO) Financial Impacts

	FACTOR1	FACTOR2	FACTOR3
RIWO3	72 *		
RIW4	73 *		
RIWO7	65 *		
RIW7	65 *		51
RIW5	60 *		
RIWO1	59 *		
RIWO2	57 *		
RIWO5	53	42 *	
RIWO6	53 *		
RIWO8	50 *		44
RIW1		70 *	
RIW2		66 *	
RIWO4		70 *	
RIWO9	50	58 *	
RIW3			82
RIW6			61

Bolded items, also highlighted by *****, indicate which items were loaded onto which factors.

Alpha values for items before taking any necessary actions were 0.82 for Factor 1 (RIWO3, RIW4, RIWO7, RIW7, RIW5, RIWO1, RIWO2, RIWO5, RIWO6, and RIWO8), 0.63 for Factor 2 (RIW1, RIW2, RIWO4, and RIWO9), and 0.43 for Factor 3 (RIW3 and RIW6). Therefore, the following two actions were taken:

- RIW3 and RIW6, loaded only onto Factor 3, were excluded from further analysis because of low reliability.

- RIWO5, which loaded onto both Factor 1 (0.53) and Factor 2 (0.42), was switched to Factor 2 for two reasons. First, RIWO 5 was conceptually more aligned with other items in Factor 2 than with items in Factor 1 because it specifically relates to multi-dimensional roles. Second, as a result, α for Factor 2 increased to 0.69 from 0.63, although switching decreased α for Factor 1 to 0.81 from 0.82. Because α of 0.81 was sufficiently high, RIWO5 was grouped in Factor 2.

In summary, 9 items (RIWO3, RIW4, RIWO7, RIW7, RIW5, RIWO1, RIWO2, RIWO6, and RIWO8) and 5 items (RIWO5, RIW1, RIW2, RIWO4, and RIWO9) were retained in Factor 1 and Factor 2. These two factors were called 'informed partners' (INFPRT; final α=0.81) and 'role integrity' (RI; final α=0.69). Therefore, for the construct role integrity, the distinction between *with* and *without* financial impacts was not supported in the empirical data.

3.5.2.3 Third factor analysis (CR & FLEX)

Six items from conflict resolution (CR) and four items from flexibility (FLEX) were entered into a factor analysis. Table 3-10 shows the factor pattern matrix.

Table 3-10. Factor Pattern Matrix for Conflict resolution (CR) and Flexibility (FLEX)

	FACTOR1	FACTOR2
CR4	82 *	
FLEX4	80 *	
FLEX3	82 *	
CR2	78 *	
CR6	73 *	
CR5	60 *	
CR3	59 *	- 43
FLEX1		
CR1		87
FLEX2		

Bolded items, also highlighted by *, indicate which items were loaded onto which factors.

All items loaded strongly onto two factors except two: FLEX1 and FLEX2. These two items were deleted because they did not load onto any factor, and because, as indicated in Table 3-7, they decreased the internal-consistency of the scale FLEX. The alpha value for the seven items loaded onto Factor 1 was 0.84. The single item CR1, loaded onto Factor 2, was deleted for the following two reasons. First, although CR1 loaded strongly onto Factor 2, it was the only item that did. Also, including it with other items in Factor 1 decreased internal-consistency (from 0.84 to 0.82). Second, as indicated in Table 3-7, this item decreased internal-consistency of the scale CR and would have been a candidate for deletion based on the reliability analysis alone.

The seven items loaded onto Factor 1 (CR4, FLEX4, FLEX3, CR2, CR6, CR5, and CR3) were called 'conflict resolution' (CR; final α=0.84).

3.5.2.4 Fourth factor analysis (MUW & MUWO)

The last factor analysis was done with the six items in mutuality with financial impact (MUW) and the two items from mutuality without financial impact (MUWO). Table 3-11 shows the factor pattern matrix.

Table 3-11. Factor Pattern Matrix for Mutuality With (MUW) and Without (MUWO) Financial Impacts

	FACTOR1	
MUWO2	**83**	*****
MUWO1	**81**	*****
MUW3	**80**	*****
MUW4	**77**	*****
MUW6	66	
MUW1	65	
MUW2	63	
MUW5	47	

Bolded items, also highlighted by *****, indicate which items were loaded onto which factors.

Four items loaded onto Factor 1. The alpha value for the items was 0.85. This factor was called 'mutuality' (MU; final α=0.85) (without differentiating *with* and *without* financial impacts). The remaining four items were excluded from future analysis because

they did not load strongly onto Factor 1 and because α for Factor 1 decreased if they were included in Factor 1.

3.5.3   Changes made in scales after factor analysis

Based on the results of the reliability analysis and the factor analysis described in the preceding sections, changes were made to the scales identified in Table 3-7 for hypothesis testing. These changes also imply changes to the four dependent variables, which are now: informed partners, role integrity, conflict resolution, and mutuality. Throughout the rest of this dissertation (Results and Discussion, Conclusion), this revised set of dependent variables is used. Table 3-12 shows new scales based on all changes.

Table 3-12. Operational Measures of Variables and Changes Made in Scales After Reliability Analysis and Factor Analysis

Variables and indicators	Operationalization of indicators and item(s)	α
__Individual demographics__ Status (or Perspective)	Customer (buyer) or supplier (seller) [Part I-1]	--
Title	[Official title] of [Dept. or section or division] [Part I-2]	
Job tenure	Number of years or months of experience with this job [Part I-3]	
Organization tenure	Number of years or months of experience with this organization [Part I-4]	
Business partnership tenure	Number of years or months of experience with this partner [Part I-5]	
__Organizations__ Total annual sales volume	Average total sales volume of the company [Part I-6]	--
Number of employees	Total number of employees [Part I-7]	
Status of the company	Parent organization? [Part I-8]	
Partner	Single vs. Multiple sources for certain items [Part I-9]	
Amount of business with the partner	% amount of sales to/purchasing from the partner [Part I-10]	
Number of partner company's employees	Total number of partner company's employees [Part I-11]	
Proportion of partnerships	% of partnership with customers and supplier [Part I-12]	
__Joint use of tools__ [**TQMT**] 5 items Joint implementation and deployment of already existing tools	[TQMT1] 1. We are using specific tools with our partner to jointly design new products.	0.71
	[TQMT2] 11. People in the two companies use mechanisms or tools to design better quality systems.	
	[TQMT3] 15. The relationship with our partner involves the use of quality tools for longer term planning.	
	[PRAC1] 7. Our partner is involved in joint planning activities with us that traditionally were considered only one party's responsibility.	
	[PRAC3] 22. The relationship with our partner includes formal evaluation and assessment.	
__Joint practices__ [**PRAC**] 4 items Personal contacts for joint planning, problem-solving, and exchange of strategic information without using specific TQM tools	[PRAC2] 8. In the relationship with our partner, there is an exchange of strategic information, such as cost and price structure.	0.65
	[PRAC5] 31. The relationship with our partner involves frequent personal contacts for exchange of ideas and information.	
	[PRAC6] 35. We are willing to put aside contract terms in order to jointly work through difficult technical or quality problems that arise.	
	[PRAC7] 44. The relationship could be described as a 'long-term joint venture' or partnership.	

Table 3-12. Operational Measures of Variables and Changes Made in Scales After Reliability Analysis and Factor Analysis (cont.)

Variables and indicators	Operationalization of indicators and item(s)	α
Informed partners [**INFPRT**] 9 items Informed partners resulting from frequent information sharing/suggestion providing	[RIW4] 24. Our partner shares information to help our company increase quality and productivity.	0.81
	[RIW5] 38. We provide each other with technical support in substantial detail.	
	[RIW7] 43. Our partner helps us identify cost reduction opportunities.	
	[RIWO1] 4. Both parties share information on performance in meeting the expectations and needs of the other.	
	[RIWO2] 10. Our partner offers specific suggestions to help us improve our processes and procedures.	
	[RIWO3] 13. Our partner is responsive in maintaining a cooperative relationship with us.	
	[RIWO6] 26. The relationship with our partner includes diverse expectations over many issues.	
	[RIWO7] 36. We keep each other informed about events or changes that may affect the other party.	
	[RIWO8] 39. We regularly provide our partner with long-range forecasts of supply capabilities or demand requirements.	
Role integrity [**RI**] 5 items Level of complexity and multi-dimensionality of roles	[RIW1] 9. We have made financial investments in our company, such as tooling, equipment, and training employees, dedicated to the relationship with our partner.	0.69
	[RIW2] 12. If our relationship with our partner were discontinued, our sales would suffer.	
	[RIWO4] 17. From time to time, we are willing to make sacrifices to help our partner.	
	[RIWO5] 25. Both parties have multi-dimensional roles that go beyond the mere buying and selling of products.	
	[RIWO9] 40. We are responsive in maintaining a cooperative relationship with our partner.	
Conflict resolution [**CR**] 7 items Level of internality and informality of mechanisms to solve problems	[CR2] 18. Problems that arise in the course of this relationship are treated as *joint* rather than *individual* responsibilities.	0.84
	[CR3] 27. Each conflict is treated as a further improvement opportunity.	
	[CR4] 30. Neither party abuses its power over the other party.	
	[CR5] 37. Rather than relying on legal procedures to resolve conflicts (i.e., filing a suit), both parties rely on more informal means.	
	[CR6] 42. Temporary setbacks in our partner's performance commitment are accepted and resolved in an aligned and negotiated way.	
	[FLEX3] 29. The relationship with our partner can be characterized as flexible.	
	[FLEX4] 32. Our partner is flexible in response to requests we make.	
Mutuality [**MU**] 4 items Level of positive incentives to cooperate with the partner and equity in the distribution of surpluses and burdens in the long-term	[MUW3] 19. Our company gets a fair share of the financial rewards and cost savings from the relationship with our partner.	0.85
	[MUW4] 20. Benefits from problem solving with our partner are shared jointly.	
	[MUWO1] 14. Both parties are committed to improvement that benefits the relationship as a whole, not just the individual parties.	
	[MUWO2] 34. There is a strong spirit of fairness in the relationship with our partner.	
Identification of tools/joint practices used and their effectiveness and internalization	45. *First*, check (√) only tools/practices your company is using jointly with your partner. *Second*, indicate the overall effectiveness of each tool or joint practice you checked by circling the appropriate number. And *third*, indicate whether or not each tool or joint practice you checked is internalized into the way you and your partner company do business by circling the appropriate number.	--
	46. Please list below any additional tools/practices not listed in Question #45 that you and your partner company are using jointly.	
Measuring perceived changes in organizational performance dimensions	47. *First*, identify the impact of using tools or joint practices by specifying a *percentage increase* or *decrease*. *Second*, identify only tools/practices that are predominantly responsible for the percentage increase/decrease in quality, cost, cycle time, and other performance dimensions.	--
	48. Based on all the tools/joint practices you identified in Questions #45 & 46, what is the ***overall*** effect on organizational performance?	
Level of satisfaction and quality of partnership	49.Overall, my level of satisfaction with this partner is very high.	--
	50.Overall, the quality of the partnership with this partner is very high.	

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In summary,

- Two independent variables – joint use of specific tools (TQMT) and joint practices (PRAC) – and four dependent variables – informed partners (INFPRT), role integrity (RI), conflict resolution (CR), and mutuality (MU) – were retained as shown in Table 3-12.

- Some items originally designed for RIW and RIWO respectively were switched to RIWO and RIW, and as a result, a new dependent variable – informed partners (INFPRT) – was created, and two previous dependent variables – RIW and RIWO – were combined to become role integrity (RI) without differentiating *with* and *without* financial impacts.

- After deleting two FLEX items, the FLEX variable was absorbed into the conflict resolution (CR) variable, and these two combined variables became CR.

- Lastly, MUW and MUWO variables were combined and became mutuality (MU) without differentiating *with* and *without* financial impacts.

3.5.4   Correlations between survey items and scale averages

Next, to see if the revised set of items correlates highly with scales (variables) they are intended to measure, correlations between all remaining items and the scale average were calculated as used in Saraph, Benson, and Schroeder (1989). Table 3-13 shows the results.

Table 3-13 suggests that items have been appropriately assigned to scales. For example, as shown in Table 3-13, because TQMT is the average of 5 items (TQMT1, TQMT2, TQMT3, PRAC1, and PRAC3), a high correlation between TQMT and the five individual items was expected. In addition, since the five items in TQMT showed relatively smaller correlations with the other scales, it was concluded that they have been assigned appropriately to the scale TQMT. (See Appendix F for in-depth information about reliability and distributions of the scales used in this research.)

Table 3-13. Correlations Between Survey Items and Scale Averages

Constructs/ Factors	Items	Construct / Factors					
		TQMT	PRAC	RI	INFPRT	CR	MU
TQMT	TQMT1	**.75**	.14	.18	.32	.09	.13
	TQMT2	**.74**	.38	.22	.56	.45	.25
	TQMT3	**.71**	.36	.37	.49	.36	.18
	PRAC1	**.62**	.54	.30	.49	.39	.34
	PRAC3	**.53**	.21	.27	.35	.17	.07
PRAC	PRAC2	.38	**.70**	.23	.48	.41	.47
	PRAC5	.40	**.68**	.24	.61	.57	.41
	PRAC6	.15	**.67**	.19	.47	.60	.36
	PRAC7	.36	**.73**	.32	.54	.59	.44
RI	RIW1	.42	.15	**.68**	.18	.04	.05
	RIW2	.08	-.01	**.71**	-.01	-.09	.15
	RIWO4	.21	.33	**.67**	.14	.28	.17
	RIWO5	.35	.40	**.51**	.46	.34	.25
	RIWO9	.28	.49	**.61**	.45	.46	.17
INFPRT	RIW4	.48	.50	.16	**.73**	.47	.42
	RIW5	.47	.53	.32	**.63**	.54	.39
	RIW7	.40	.56	.06	**.69**	.46	.45
	RIWO1	.49	.46	.14	**.65**	.52	.41
	RIWO2	.42	.38	.22	**.62**	.35	.26
	RIWO3	.30	.51	.15	**.64**	.50	.48
	RIWO6	.41	.40	.32	**.57**	.29	.25
	RIWO7	.29	.54	.13	**.60**	.51	.40
	RIWO8	.38	.41	.30	**.60**	.26	.15
CR	CR2	.35	.63	.28	.58	**.78**	.48
	CR3	.35	.45	.24	.49	**.64**	.31
	CR4	.26	.58	.17	.50	**.83**	.55
	CR5	.19	.51	.32	.38	**.60**	.32
	CR6	.37	.59	.18	.53	**.73**	.48
	FLEX3	.33	.65	.14	.62	**.83**	.66
	FLEX4	.31	.60	-.03	.63	**.78**	.64
MU	MUW3	-.39	-.60	-.32	-.60	.38	**.74**
	MUW4	.28	.69	.19	.51	.65	**.82**
	MUWO1	.30	.56	.12	.51	.63	**.83**
	MUWO2	.39	.57	.20	.62	.61	**.82**

Based on the revisions made to the scales, it was necessary to revise the operational research model. Figure 3-4 shows revised Operational Research Model and reflects all the changes described in this chapter.

JOINT ACTION (Independent variable)

TQMT   **PRAC**

H1-H4   H5-H8

INFPRT   **RI**   **CR**   **MU**

SHARED RESULTS (Dependent variable)

Perceived Changes in Performance Outcomes

Research Question #1:
What tools and joint
practices are used?

Research Question #2:
How effective and internalized
are tools and
joint practices?

Research Question #3:
Relationship between
independent
and dependent variables?

Research Question #4:
What changes are perceived
in performance outcomes?

Figure 3-4. Operational Research Model (Revised)

3.6   *Data Analysis Procedures*

Besides the respondent profiles derived from the first part of the mailed survey questionnaire and the statistical data and information derived from the statistical techniques mentioned earlier, the researcher further analyzed the data to address the research questions. (All data analysis methods explained in this section were used three times: two times to analyze data collected from each of the two respondent groups – customers and suppliers separately, and once to analyze all the data together. The first two analyses enabled the researcher to compare and/or contrast results from each of the two groups.) Specific statistical techniques, described in this section, were selected based on the assistance from the Virginia Tech Statistical Consulting Center.

3.6.1   Analysis for research question 1

To address the first research question – **What joint tools and practices have been used by U.S. private manufacturing companies in q1-q3 joint action?** – the responses to the mailed survey questionnaire Items # 45 and 46 were analyzed. The total number of responses that each tool and joint practice received was counted to produce Table 3-14. The table shows what tools and joint practices have been used by the sampled organizations for their partnerships and joint action.

Table 3-14. Tools and Joint Practices Used in q1-q3 Partnerships

Tools/practices	# of responses (Frequency)	Percentage
Tool/joint practice 1	aa	xx
Tool/joint practice 2	bb	yy
:	:	:
:	:	:
Tool/joint practices 10	kk	vv
:	:	zz
:	:	:
Tool/joint practices 18	:	:
Total	ABC	100

(Data Source: Item numbers # 45-46 of the mailed survey questionnaire)

In addition to the findings in Table 3-14, the average number of tools and joint practices used in each company was also calculated.

3.6.2 Analysis for research question 2

Although Table 3-14 showed the tools and joint practices most widely used in q1-q3 partnerships, it did not address which tools and joint practices have and have not been more *or* less effective and internalized. To address the second research question – **Which tools and joint practices have been more effective and internalized in q1-q3 joint action?** – responses to the mailed survey questionnaire Items # 45-46 were further analyzed, using one-way ANOVA, described in Section 3.6.2.1, to differentiate tools and joint practices used effectively and that have been more internalized from others considered not effective and less internalized.

3.6.2.1 One-way ANOVA for quantitative data analysis

To show the level of effectiveness and internalization of each tool/joint practice, one-way ANOVA was used as follows:

1. Using 18 tools and joint practices in survey Item # 45, the actual scores of each tool and joint practice were used as input to Table 3-15. (The shaded area was filled with the actual scores from the mailed survey questionnaire.)

2. Using the actual scores, mean values of each tool and joint practice – level of effectiveness and internalization – were calculated in the last row of Table 3-15.

3. Then, one-way ANOVA made a null hypothesis, $H_0 : \mu_{\text{Tool/joint practice 1}} = \mu_{\text{Tool/joint practice 2}} = --- = \mu_{\text{Tool/joint practice 18}}.$

4. Based on the mean values in the last row, the null hypothesis was accepted or rejected by comparing the mean values in a pairwise fashion. (Although it was said that the mean values of each tool and joint practice were compared, the ANOVA actually used variance [t- or F-test] of each tool/joint practice in this step. See Montgomery [1991] for more detailed information about one-way ANOVA.)

5. If the null hypothesis was accepted, the level of effectiveness and internalization of each tool and joint practice identified was thought to be the same. If, however, the null hypothesis was rejected, a multiple range test (or paired test) was conducted to group those tools and joint practices whose effectiveness and internalization levels fell into the same range.

Table 3-15. One-way ANOVA

Joint Action	Tool/joint practice 1	Tool/joint practice 2	-----	Tool/joint practice 18
Actual Scores				
Mean (Level of effectiveness and/or internalization)	μ Tool/joint practice 1	μ Tool/joint practice 2	-----	μ Tool/joint practice 18

Using the above one-way ANOVA steps, tools and joint practices in each range grouped in step 5 could be labeled as more *or* less effective and/or internalized than others in other groups or ranges. (Note that because the scales used to measure independent and dependent variables were 6 point ordinal scales, it was impossible to infer *by how much* the effectiveness and internalization of tools and joint practices in one range was higher or lower than the effectiveness and internalization of tools and joint practices in other ranges. To make such an inference, the mailed survey questionnaire would need to use interval or ratio scales, where this mailed survey questionnaire used ordinal scales.)

3.6.3 Analysis for research question 3

To answer the third research question − **What is the relationship between tools and joint practices and shared results perceived by customer and supplier?** − the eight hypotheses in Figure 3-4 were tested using a two-way or one-way ANOVA. Given no information on the interaction between two independent variables, TQMT and PRAC, two situations were considered to test the hypotheses − (1) interaction between the two independent variables and (2) no interaction between the two independent variables − depending on the statistical significance level obtained from the two-way ANOVA.

3.6.3.1 Interaction between TQMT and PRAC

In this research, a significance level (Type I[2] error or α value) of 0.1 was selected to test for interaction between the two independent variables before data analysis for the following two reasons. First, in examining the effect of joint action on each of the four dependent variables, it is very unlikely that any dependent variable is affected by either one of independent variables only. For example, in examining the effect of JIT delivery/production on mutuality, it is difficult to say that observed or perceived effects on mutuality is caused by JIT delivery/production only. It is likely that there are also effects from other joint practices, such as joint planning and face-to-face meetings.

In the situation just mentioned, it is easy to make a Type I error (rejecting a hypothesis when it should not have been rejected) if the researcher uses the significance level of 0.05, which is conventional, or lower. In the context of this research, it is likely that the researcher may conclude that there is no interaction between TQMT and PRAC when, in fact, there is interaction between them because of the similar nature of TQMT and PRAC if the significance level of 0.05 or lower is used.

A second reason for using a 0.1 significance level is to prevent the unreasonably high ratios of Type II to Type I error rates that have been discussed in behavioral

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[2] Type I error refers to the error of rejecting the null hypothesis when it should not have been rejected, while Type II error refers to failure to reject the null hypothesis when it should have been rejected (Pedhazur & Schmelkin, 1991).

research[3]. The following are some examples of discussions on why higher α value should be used to increase statistical power[4] of survey research.

- "-- most sociobehavioral researchers choose α by convention, usually 0.05. Although, generally speaking, there is a good reason for the selection of a relatively small α to guard against false positive findings, blind adherence to convention is clearly unwise. Suffice to point out that the consequences of false positive findings may vary greatly depending, among other things, on the area of study and the costs involved" (Cowles and Davis, 1982, p. 556). In the case of this research, using a significance level of 0.05 or lower may increase Type I error as mentioned above.

- "Given a certain response rate and fixed effect size (defined as 'the degree to which the phenomenon is present in the population' [Cohen, 1988]), increasing α may be the only feasible strategy for maximizing the statistical power of the study, 1-β" (Cascio and Zedeck, 1983, p. 517).

- Rosnow and Rosenthal (1989) also showed the perceived seriousness of Type II to Type I errors for the conventional 0.05 level of α and 0.1 level of α using the following table in which the number of responses and effect size (validity coefficient) are fixed. Table 3-16 indicates two things. First, Type I errors are regarded as much more serious than Type II errors. For example, if the likelihood of a Type II error is 0.90 and the likelihood of a Type I error is 0.10, then the ratio of 0.90/0.10 indicates that the error in rejecting the null hypothesis when it is true (Type I error) is taken nine times more seriously than the error in failing to reject the null hypothesis when it is false (Type II error). Second, this phenomenon becomes more serious as a lower α value is used. The goal in determining whether or not there is an interaction between

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[3] Course notes from Psychology 5315, Research Methods, taught by Dr. Neil Hauenstein, Professor of Psychology at Virginia Tech, also encouraged the researcher to use the significance level of 0.1: "--- either no use of significance levels or use of higher significance levels will be one of future trends ---" (Course notes, Fall 1996).

[4] The power of statistical test, labeled as 1-β (Type II error), refers to the power of test to reject the null hypothesis when it should be rejected (Pedhazur & Schmelkin, 1991).

Table 3-16. Ratio of Type II to Type I Error Rates for Various Responses, Effect Sizes, and Significance Levels
(Source: Rosnow and Rosenthal, 1989)

Number of responses	Effect sizes (r^*) and significance levels (p^{**})					
	r=0.10		r=0.30		r=0.50	
	p=0.05	p=0.10	p=0.05	p=0.10	p=0.05	p=0.10
10	19	9	17	8	13	5
20	19	9	15	6	7	2
30	18	8	13	5	3	1
40	18	8	19	4	2	--
50	18	8	9	3	--	--
100	17	7	3	--	--	--
200	14	6	--	--	--	--
300	12	5	--	--	--	--
400	10	4	--	--	--	--
500	8	3	--	--	--	--
600	6	2	--	--	--	--
700	5	2	--	--	--	--
800	4	1	--	--	--	--
900	3	--	--	--	--	--
1000	2	--	--	--	--	--

*: Effect size refers to "the degree to which the phenomenon is present in the population," or "the degree to which the null hypothesis is false" (Cohen, 1988, p. 9-10). In other words, effect size is the magnitude of the correlation in the population (correlation coefficients).

**: "A p value refers to the probability of the evidence having arisen as a result of sampling errors, given that the null hypothesis is true" (Pedhazur & Schmelkin, 1991, p. 200).

TQMT and PRAC is to lower both Type I error (concluding that there is no interaction between TQMT and PRAC when, in fact, there is an interaction) and Type II error (concluding that there is an interaction between TQMT and PRAC when, in fact, there is no interaction). To achieve this goal, α of 0.1 was chosen for this research[5] in determining whether or not there was interaction between TQMT and PRAC. However, α of higher than 0.1 was not used because no precedent for this was found in other studies.

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[5] However α of conventional 0.05 was used to test hypotheses from ANOVA.

3.6.3.2 *Two-way ANOVA with interaction between two independent variables*

Assuming there was interaction between the two independent variables, Table 3-17 could be derived using a two-way ANOVA. Then, using similar steps to the one-way ANOVA explained in Section 3.6.2.1, the two-way ANOVA did the following:

Table 3-17. Two-Way ANOVA with Interaction Between the Two Independent Variables

TQMT (Mean score) PRAC	1 (Low)	2	3	4	5	6 (High)	Average
1(Low)	(1)	(2)	(3)	(4)	(5)	(6)	μ (PRAC1)
2	(2)	(3)	(4)	(5)	(6)	(7)	μ (PRAC2)
3	(3)	(4)	(5)	(6)	(7)	(8)	μ (PRAC3)
4	(4)	(5)	(6)	(7)	(8)	(9)	μ (PRAC4)
5	(5)	(6)	(7)	(8)	(9)	(10)	μ (PRAC5)
6(High)	(6)	(7)	(8) MU: 4.0	(9)	(10)	(11)	μ (PRAC6)
Average	μ (TQMT1)	μ (TQMT2)	μ (TQMT3)	μ (TQMT4)	μ (TQMT5)	μ (TQMT6)	--

(To illustrate how the two-way ANOVA was used, one of the dependent variables – mutuality – is selected as an example.)

1. First, using scores on mailed survey questionnaire items for TQMT and PRAC, each response's mean levels of TQMT and PRAC were determined. Then, the mean level of mutuality was calculated and this value was used as an input to the shaded area of the Table 3-17. For example, if the mean levels[6] of TQMT and PRAC were 2 and 6 respectively, then the calculated mean level of mutuality, say 4.0, was recorded in the cell indicated.

2. Using the same procedures as in step 1, mean scores on mutuality of all returned responses were calculated and used as inputs to Table 3-17.

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[6] TQMT and PRAC were treated as class variables in ANOVA as follows:
If $0 \leq$ mean levels < 1.5, then the value of 1 was assigned to TQMT or PRAC; if $1.5 \leq$ mean levels < 2.5, then the value of 2 was assigned to TQMT or PRAC; if $2.5 \leq$ mean levels < 3.5, then the value of 3 was assigned to TQMT or PRAC; if $3.5 \leq$ mean levels < 4.5, then the value of 4 was to TQMT or PRAC; if $4.5 \leq$ mean levels < 5.5, then the value of 5 was assigned to TQMT or PRAC; and if $5.5 \leq$ mean levels ≤ 6.0, then the value of 6 was assigned to TQMT or PRAC.

3. Mean levels of mutuality in all cells were calculated.

4. Two-way ANOVA made a null hypothesis, $H_0 : \mu_{Cell\ 1} = \mu_{Cell\ 2} = \text{-----}$.

5. Based on all mean values just calculated, the null hypothesis would be accepted or rejected by comparing the mean values in a pairwise fashion using the same mathematical procedures (t- or F-test) briefly introduced in Section 3.6.2.1. This was done using the Student-Newman-Keuls multiple range test in Step 6.

6. Student-Newman-Keuls (SNK: SAS User's Guide, 5th Ed.) multiple range test was conducted to determine if differences between mean values were significant such that the null hypothesis would be rejected and the hypothesized relationship between combined TQMT+PRAC and MU would be supported. To do this, the following four decision criteria[7] were used:

   ① μ (TQMT1) < μ (TQMT2) < μ (TQMT3) < μ (TQMT4) < μ (TQMT5) < μ (TQMT6);

   ② μ (PRAC1) < μ (PRAC2) < μ (PRAC3) < μ (PRAC4) < μ (PRAC5) < μ (PRAC6);

   ③ μ [Average of cell labeled (1)] < μ [Average of cells labeled (2)] < μ [Average of cells labeled (3)] < μ [Average of cells labeled (4)] < ----- < μ [Average of cell labeled (11)]; &

   ④ No average values used in ①, ②, and ③ should be grouped in more than one SNK grouping (see Table 3-17).

   If the differences between mean values were statistically significant (or all four decision criteria were met) at an alpha level of 0.05, then the null hypothesis was rejected and the hypothesized relationship between combined TQMT+PRAC and MU was supported. Otherwise, the hypothesized relationship between combined TQMT+PRAC and MU was not supported. (See Section 4.4 for in-depth procedures and results of Student-Newman-Keuls multiple range test.)

7. Using the above step 1-6, all 8 hypotheses were tested.

3.6.3.3 One-way ANOVA with no interaction between two independent variables

Assuming there was no interaction between the two independent variables, Table

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[7] Decision criteria were provided by the Virginia Tech Statistical Consulting Center and Dr. Robert Williges, Professor of Industrial & Systems Engineering at Virginia Tech.

3-17 was simplified, as shown in Table 3-18.

Table 3-18. One-Way ANOVA with No Interaction Between the Two Independent Variables

Level of TQMT or PRAC	1 (Low)	2	3	4	5	6
Level of mutuality		MU: 4.8				
μ[Mutuality]	μ (TQMT1)	μ (TQMT2)	μ (TQMT3)	μ (TQMT4)	μ (TQMT5)	μ (TQMT6)

1. First, using scores on mailed survey questionnaire items for TQMT or PRAC, each response's mean levels of TQMT and PRAC were determined. Then, the mean level of mutuality was calculated and this value was used as an input to the shaded area of Table 3-18. For example, if the mean levels of TQMT (or PRAC) was 2, then the calculated level of mutuality, say 4.8, was recorded in the cell indicated.

2. Using the same procedures in step 1, mean scores on mutuality of all returned responses were calculated and used as inputs to Table 3-18.

3. Mean levels of mutuality in all 6 cells were calculated in the last row.

4. One-way ANOVA made a null hypothesis, $H_0 : \mu_{Cell\ 1} = \mu_{Cell\ 2} = --- = \mu_{Cell\ 6}$.

5. Based on the 6 mean values just calculated, the null hypothesis was accepted or rejected by comparing the mean values in a pairwise fashion using the same mathematical procedures (t- or F-test) briefly introduced in Section 3.6.2.1. This was done by Student-Newman-Keuls multiple range test in Step 6.

6. Student-Newman-Keuls multiple range test was conducted to determine if differences between mean values were significant enough to reject the null hypothesis. To do this, the following two decision criteria were used:

    ① μ (TQMT1) < μ (TQMT2) < μ (TQMT3) < μ (TQMT4) < μ (TQMT5) < μ (TQMT6);
    or μ (PRAC1) < μ (PRAC2) < μ (PRAC3) < μ (PRAC4) < μ (PRAC5) < μ (PRAC6);
    ② No average values used in ① should be grouped in more than one SNK grouping (see Table 3-18).

    If the differences between mean values were statistically significant (or the two decision criteria were met) at alpha level of 0.05, then the null hypothesis was rejected.

In other words, the hypothesized relationship between TQMT (or PRAC) and the level of mutuality was supported. Otherwise, the null hypothesis was accepted and the hypothesized relationship between TQMT (or PRAC) and the level of mutuality was not supported.

7. Using the above steps 1-6, the relationships between TQMT (or PRAC) and all other dependent variables were tested.

3.6.4   Analysis for research question 4

Items # 47 and 48 of the mailed survey questionnaire were used to answer the fourth research question – **What changes (increase or decrease) in organizational performance dimensions (quality, cost, cycle time, and overall) are perceived as a result of q1-q3 joint action and shared results?** Items # 47 and 48 were designed to obtain the following information. First, both specific (quality, cost, and cycle time; Item # 47) and overall (Item # 48) changes in organizational performance could be obtained in terms of percentage increase or decrease. Second, tools and practices in Item # 45 would be categorized such that tools/practices in each category were predominantly responsible for the percentage of increase or decrease in each of the three performance dimensions (Item # 47). These findings explained what tools/practices have been used frequently, or infrequently, to increase, or decrease, costs or cycle time, for example.

CHAPTER 4. RESULTS AND DISCUSSION

This chapter presents results for the four research questions as well as a profile of survey respondents. Section 4.1 shows the survey respondents profile in-depth, while Sections 4.2, 4.3, 4.4, and 4.5 present detailed key results from the four research questions using quantitative data (from the survey) and qualitative data (from the structured interviews). The four research questions are shown in Table 4-1, followed by a brief description of the data analysis methods and summary results obtained.

4.1   Survey Respondents Profile

Part I of the survey was designed to collect data that were used to analyze the respondents profile. The survey respondents profile consists of two parts – individual profile and organizational profile, shown below.

4.1.1   Individual respondents profile

As described earlier, a total of 172 surveys were returned, with an overall response rate of 9.78%. Using these 172 returned surveys, the following information about individual respondents were derived.

Customer: 94 (55%)   Supplier: 78 (45%)
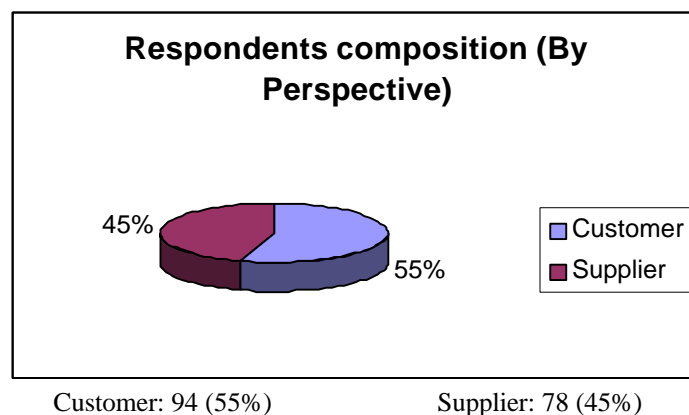
Figure 4-1. Respondents' Composition (By Perspective Selected)

Table 4-1. Overview of Research Questions, Data Analysis Methods, and Summary Results

Research question	Data analysis method	Summary results (From the overall perspective[*])
Research question #1: What joint tools and practices have been used by U.S. private manufacturing companies in q1-q3 joint action?	Average number of tools/joint practices	Average number of tools and joint practices used: 9.1
	How many tools/joint practices have been used by how many U.S. private manufacturing companies in their q1-q3 relationship?	6-10 and 0-5 tools and joint practices have been used by 75 (45%) and 41 (24%) companies
	Frequency of each tool/joint practice used	Five most frequently used tools and joint practices: supplier certification/verification, joint problem-solving teams, quality audit, JIT delivery/production, and joint planning. Five least frequently used tools and joint practices: quality circles, gainsharing, quality function deployment, joint investment on R&D, and in-plant representative
Research question #2: Which tools and joint practices have been more effective and internalized in q1-q3 joint action?	One-way ANOVA: to test for any differences in the levels of effectiveness and internalization for each tool and joint practice. Duncan multiple range test: to group those tools and joint practices whose effectiveness and internalization levels fell into the same range	Five tools and joint practices used most effectively: ISO 9000 and/or QS 9000 and/or Baldrige criteria, quality audit, JIT delivery/production, joint planning, and joint problem-solving teams. Five tools and joint practices used least effectively: benchmarking, cost of quality, quality circles, gainsharing, and quality function deployment. Five most internalized tools and joint practices: ISO 9000 and/or QS 9000 and/or Baldrige criteria, quality audit, JIT delivery/production, joint problem-solving teams, and supplier or customer performance measurement system. Five least internalized tools and joint practices: cost of quality, gainsharing, quality circles, benchmarking, and quality function deployment
Research question #3: What is the relationship between tools and joint practices and shared results perceived by customer and supplier?	Two-way ANOVA: to determine if there is an interaction between two independent variables in examining their combined relationships with four dependent variables (significance level used : 0.1). One-way ANOVA: to test hypothesized relationships between each of two independent variables and each of four dependent variables	H1 (TQMT-INFPRT): supported. H5 (PRAC-INFPRT): supported. H2 (TQMT-RI): not supported. H6 (PRAC-RI): supported. H3 & H7 ((TQMT+PRAC)-CR): not supported. H4 & H8 ((TQMT+PRAC)-MU): not supported
Research question #4: What changes (increase or decrease) in organizational performance dimensions (quality, cost, and cycle time) are perceived as a result of q1-q3 joint action and shared results?	Average perceived changes in three organizational performance dimensions. Tools/joint practices used to improve/decrease three perceived organizational performance dimensions. The overall effect on organizational performance	Quality: 30% increase; Cost: 21% decrease; and cycle time: 26% decrease. For quality improvement: SPC, joint problem-solving teams, and quality audit. For cost reduction: JIT delivery/production, joint problem-solving teams, and exchange of strategic information. For cycle time reduction: JIT delivery/ production, joint planning, and exchange of strategic information

*: See following sections for more detailed results.

Ninety-four surveys were answered and returned by people who took the customer (buyer) perspective and 78 surveys by the supplier (seller) perspective. These 172

responses were further analyzed to define other respondents' composition categorized by their official titles.
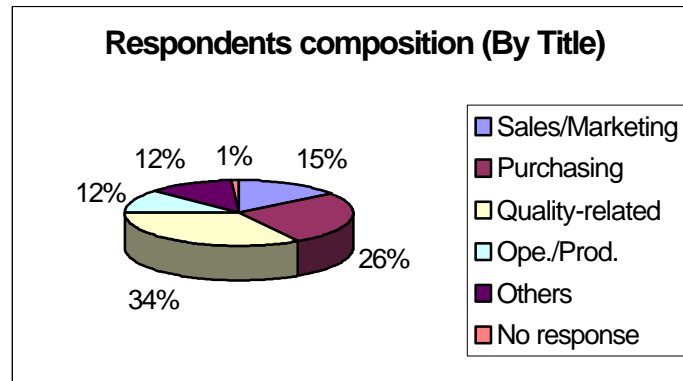
Managers of: Sales/Marketing: 26 (15%)   Purchasing (Buying): 45 (26%)
Quality-related: 57 (34%)   Operations/Production: 21 (12%)
Others (VP, General manager, etc.): 21 (12%)
No response: 2 (1%)

Figure 4-2. Respondents' Composition (By Official Title)

As shown in Figure 4-2, more managers of purchasing and quality-related functions, such as Quality Assurance and Quality Control departments, participated in the mailed survey questionnaire than did managers of any other function. Note that one of the titles is termed *Others*. This group includes, but is not limited to, higher level managers such as president, vice president, and general managers. One possible reason for these higher level managers' participation is that their companies are relatively smaller than other participating individuals' companies, so they do not have specific functions such as sales/marketing, purchasing, and operations/production. For example, only 4 out of the 21 companies represented by respondents in this group have more than 5,000 employees.

To see how many managers took the customer and supplier perspective respectively, Figures 4-1 and 4-2 were combined. Table 4-2 shows the result. As expected, most managers of purchasing and sales/marketing functions took the customer and supplier perspective, respectively (purchasing managers' customer perspective: 43/45

and sales/marketing managers' supplier perspective: 24/26). Managers of quality-related
functions spread relatively evenly between the two perspectives (customer perspective:
30/57 and supplier perspective: 27/57). More managers of operations/production took the
customer perspective, while more higher level managers took the supplier perspective.

Table 4-2. Respondents' Composition (By Perspective & Official Title)

Frequency Row %	Sales/ Marketing	Purchas- ing	Quality- related	Operations/ Production	Others	No response	Total
Customer	2	43	30	12	7	0	94
	2.13	45.74	31.91	12.77	7.45	0.00	
Supplier	24	2	27	9	14	2	78
	30.77	2.56	34.62	11.54	17.95	2.56	
Total	26	45	57	21	21	2	172

All respondents' experiences with their current jobs, organizations, and particular
partner that was used in completing the survey were further examined in terms of number
of years (and months). The results are shown in Table 4-3 and Figures 4-3, 4-4, and 4-5.

Table 4-3. Respondents' Experience in Years with Current Job/Organization/Partner

	Job			Organization			Partner		
	Overall	Customer	Supplier	Overall	Customer	Supplier	Overall	Customer	Supplier
Mean	10.15	10.97	9.16	11.36	11.53	11.15	15.88	12.25	20.16
Std Dev	8.34	8.78	7.71	9.75	10.04	9.46	13.96	13.02	13.91

Two interesting results were revealed by Table 4-3. First, respondents'
experience with a particular partner is longer than their experience with their current job
and organization (all three categories: overall, customer, and supplier). Second,
respondents' experiences with a partner who took the supplier perspective (20.16 years)
is much longer than that of those who took the customer perspective's (12.25 years).
Two points can be made from this information. First, it appears that people are more
likely to maintain partnerships with a particular partner even after they change their job

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and/or company. Second, participants who chose the supplier perspective appear to rely on long-term partnerships more than those who selected the customer perspective.

	Midpoint (years)		Freq	Cum. Freq	Percent	Cum. Percent
Customer	2.5	, *************************	26	26	15.12	15.12
[Mean: 10.97]	5.0	, ***************	15	41	8.72	23.84
	7.5	, ******	6	47	3.49	27.33
	10.0	, **********	10	57	5.81	33.14
	12.5	, *	1	58	0.58	33.72
	15.0	, ********	8	66	4.65	38.37
	17.5	, ****	4	70	2.33	40.70
	20.0	, ************	12	82	6.98	47.67
	22.5	, ***	3	85	1.74	49.42
	25.0	, ****	4	89	2.33	51.74
	27.5	, *	1	90	0.58	52.33
	30.0	, **	2	92	1.16	53.49
	32.5	, *	1	93	0.58	54.07
	35.0	, *	1	94	0.58	54.65
	37.5	,	0	94	0.00	54.65
	40.0	,	0	94	0.00	54.65
	42.5	,	0	94	0.00	54.65
	45.0	,	0	94	0.00	54.65
	47.5	,	0	94	0.00	54.65
		,				
Supplier	2.5	, ****************	16	110	9.30	63.95
[Mean: 9.16]	5.0	, ********************	20	130	11.63	75.58
	7.5	, ***************	15	145	8.72	84.30
	10.0	, *******	7	152	4.07	88.37
	12.5	, ****	4	156	2.33	90.70
	15.0	, *******	7	163	4.07	94.77
	17.5	, **	2	165	1.16	95.93
	20.0	,	0	165	0.00	95.93
	22.5	,	0	165	0.00	95.93
	25.0	, **	2	167	1.16	97.09
	27.5	,	0	167	0.00	97.09
	30.0	, ****	4	171	2.33	99.42
	32.5	,	0	171	0.00	99.42
	35.0	, *	1	172	0.58	100.00
	37.5	,	0	172	0.00	100.00
	40.0	,	0	172	0.00	100.00
	42.5	,	0	172	0.00	100.00
	45.0	,	0	172	0.00	100.00
	47.5	,	0	172	0.00	100.00
		,				

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      5    10   15   20   25   Frequency
```

Figure 4-3. Distribution of Job Experience (By Perspective)

	Midpoint (years)		Freq	Cum. Freq	Percent	Cum. Percent
Customer	2.5	, ************************	25	25	14.53	14.53
[Mean: 11.53]	5.0	, ******************	18	43	10.47	25.00
	7.5	, *******	7	50	4.07	29.07
	10.0	, *******	7	57	4.07	33.14
	12.5	, ****	4	61	2.33	35.47
	15.0	, *****	5	66	2.91	38.37
	17.5	, ****	4	70	2.33	40.70
	20.0	, *******	7	77	4.07	44.77
	22.5	, *	1	78	0.58	45.35
	25.0	, ****	4	82	2.33	47.67
	27.5	, *****	5	87	2.91	50.58
	30.0	, ***	3	90	1.74	52.33
	32.5	, **	2	92	1.16	53.49
	35.0	, *	1	93	0.58	54.07
	37.5	,	0	93	0.00	54.07
	40.0	, *	1	94	0.58	54.65
	42.5	,	0	94	0.00	54.65
	45.0	,	0	94	0.00	54.65
	47.5	,	0	94	0.00	54.65
		,				
Supplier	2.5	, ******************	18	112	10.47	65.12
[Mean: 11.15]	5.0	, *************	13	125	7.56	72.67
	7.5	, *********	9	134	5.23	77.91
	10.0	, *********	9	143	5.23	83.14
	12.5	, **	2	145	1.16	84.30
	15.0	, ******	6	151	3.49	87.79
	17.5	, ******	6	157	3.49	91.28
	20.0	, ****	4	161	2.33	93.60
	22.5	, **	2	163	1.16	94.77
	25.0	, **	2	165	1.16	95.93
	27.5	, *	1	166	0.58	96.51
	30.0	, **	2	168	1.16	97.67
	32.5	, *	1	169	0.58	98.26
	35.0	, **	2	171	1.16	99.42
	37.5	, *	1	172	0.58	100.00
	40.0	,	0	172	0.00	100.00
	42.5	,	0	172	0.00	100.00
	45.0	,	0	172	0.00	100.00
	47.5	,	0	172	0.00	100.00

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    5   10   15   20   25   Frequency

Figure 4-4. Distribution of Organization Experience (By Perspective)

	Midpoint (years)	Freq	Cum. Freq	Percent	Cum. Percent
Customer	2.5, **	22	22	13.10	13.10
[Mean:	5.0, **************************	14	36	8.33	21.43
12.25]	7.5, ****************	8	44	4.76	26.19
	10.0, ************************	13	57	7.74	33.93
	12.5, **	1	58	0.60	34.52
	15.0, **************************	13	71	7.74	42.26
	17.5, ******	3	74	1.79	44.05
	20.0, **********	5	79	2.98	47.02
	22.5,	0	79	0.00	47.02
	25.0, ******	3	82	1.79	48.81
	27.5, ****	2	84	1.19	50.00
	30.0, ********	4	88	2.38	52.38
	32.5,	0	88	0.00	52.38
	35.0,	0	88	0.00	52.38
	37.5,	0	88	0.00	52.38
	40.0,	0	88	0.00	52.38
	42.5,	0	88	0.00	52.38
	45.0,	0	88	0.00	52.38
	47.5, ******	3	91	1.79	54.17
	,				
Supplier	2.5, ********	4	95	2.38	56.55
[Mean:	5.0, **************	7	102	4.17	60.71
20.16]	7.5, ****	2	104	1.19	61.90
	10.0, **********************	12	116	7.14	69.05
	12.5, **********	5	121	2.98	72.02
	15.0, ************************	13	134	7.74	79.76
	17.5, ****	2	136	1.19	80.95
	20.0, ************	6	142	3.57	84.52
	22.5,	0	142	0.00	84.52
	25.0, **********	5	147	2.98	87.50
	27.5, **	1	148	0.60	88.10
	30.0, **************	7	155	4.17	92.26
	32.5,	0	155	0.00	92.26
	35.0, **	1	156	0.60	92.86
	37.5, **	1	157	0.60	93.45
	40.0, ******	3	160	1.79	95.24
	42.5,	0	160	0.00	95.24
	45.0,	0	160	0.00	95.24
	47.5, ****************	8	168	4.76	100.00

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         2   4   6   8   10  12  14  16  18  20  22    Frequency
```

Figure 4-5. Distribution of Partner Experience (By Perspective)

As shown in Table 4-3 and Figures 4-3 through 4-5, average experiences with current job, organization, and partner were: 10.97, 11.53, and 12.25 years from the customer perspective, and 9.16, 11.15, and 20.16 years from the supplier perspective.

Regardless of the perspective chosen, about 60% of respondents' experience with their current job and organization fall between 0 and 10 years (customer: 57/94, and supplier: 58/78). However, the suppliers' partner experience is more heavily distributed between 10 and 15 years, while most of the customers' partner experience is distributed between 2.5 and 10 years.

4.1.2 Organizational profile

First, the average total annual sales volume was examined. Results are shown in Table 4-4 and Figure 4-6.

Table 4-4. Average Total Annual Sales Volume (in Million Dollars)

(Frequency missing: 5)

Frequency Row %	< 0.5	0.5-1	1-5	5-10	10-25	25-50	50-75	75-100	> 100	Total
Customer	0	0	2	2	15	10	4	16	43	92
	0.00	0.00	2.17	2.17	16.30	10.87	4.35	17.39	46.74	
Supplier	2	0	2	4	19	14	3	7	24	75
	2.67	0.00	2.67	5.33	25.33	18.67	4.00	9.33	32.00	
Total	2	0	4	6	34	24	7	23	67	167

According to Table 4-4, most customer and supplier companies are either medium- or large-size companies, because more than 70% of respondents indicated their average total annual sales volume ranges between $10M and 50M and more than $100M. For both customers and suppliers, the average total annual sales volume of more than $100M was the range that received more responses than did any other ranges.

Second, participating companies' total number of employees was examined. Table 4-5 shows the results. For both customers and suppliers, the range of 100-500 was the most common number of employees (customer: 32.98% and supplier: 47.44%). Only about 20% of customer companies' and 11% of supplier companies' total number of employees was over 5,000.

Third, it was found that more than 60% (57/94) of customer companies and 51% (40/78) of supplier companies are part of a larger parent organization.

Frequency

```
                                   **
      ,                            **
      ,                            **
      ,                            **
  40  ^                            **              1: Less than $500,00
      ,                            **              2: $500,000-1M
      ,                            **              3: $1-5M
      ,                            **              4: $5-10M
      ,                            **              5: $10-25M
  35  ^                            **              6: $25-50M
      ,                            **              7: $50-75M
      ,                            **              8: $75-100M
      ,                            **              9: More than $100M
      ,                            **
  30  ^                            **
      ,                            **
      ,                            **
      ,                            **
      ,                            **
  25  ^                            **
      ,                            **                            **
      ,                            **                            **
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      ,                            **                            **
  20  ^                            **                            **
      ,                            **                   **       **
      ,                            **                   **       **
      ,                            **                   **       **
      ,                     **  **                      **       **
  15  ^               **    **  **                      **       **
      ,               **    **  **                   ** **       **
      ,               **    **  **                   ** **       **
      ,               **    **  **                   ** **       **
      ,               **    **  **                   ** **       **
  10  ^               ** **  **  **                   ** **       **
      ,               ** **  **  **                   ** **       **
      ,               ** **  **  **                   ** **       **
      ,               ** **  **  **                   ** **    ** **
      ,               ** **  **  **                   ** **    ** **
   5  ^               ** **  **  **                   ** **    ** **
      ,               ** ** ** ** **          ** ** **    ** **
      ,               ** ** ** ** **          ** ** ** ** ** **
      ,         ** ** ** ** ** ** **    **  ** ** ** ** ** ** **
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          1  2  3  4  5  6  7  8  9    1  2  3  4  5  6  7  8  9      SALES VOLUME
         ,ƒƒƒƒƒƒ  Customer  ƒƒƒƒƒƒƒ,   ,ƒƒƒƒƒƒƒ Supplier ƒƒƒƒƒƒƒ,
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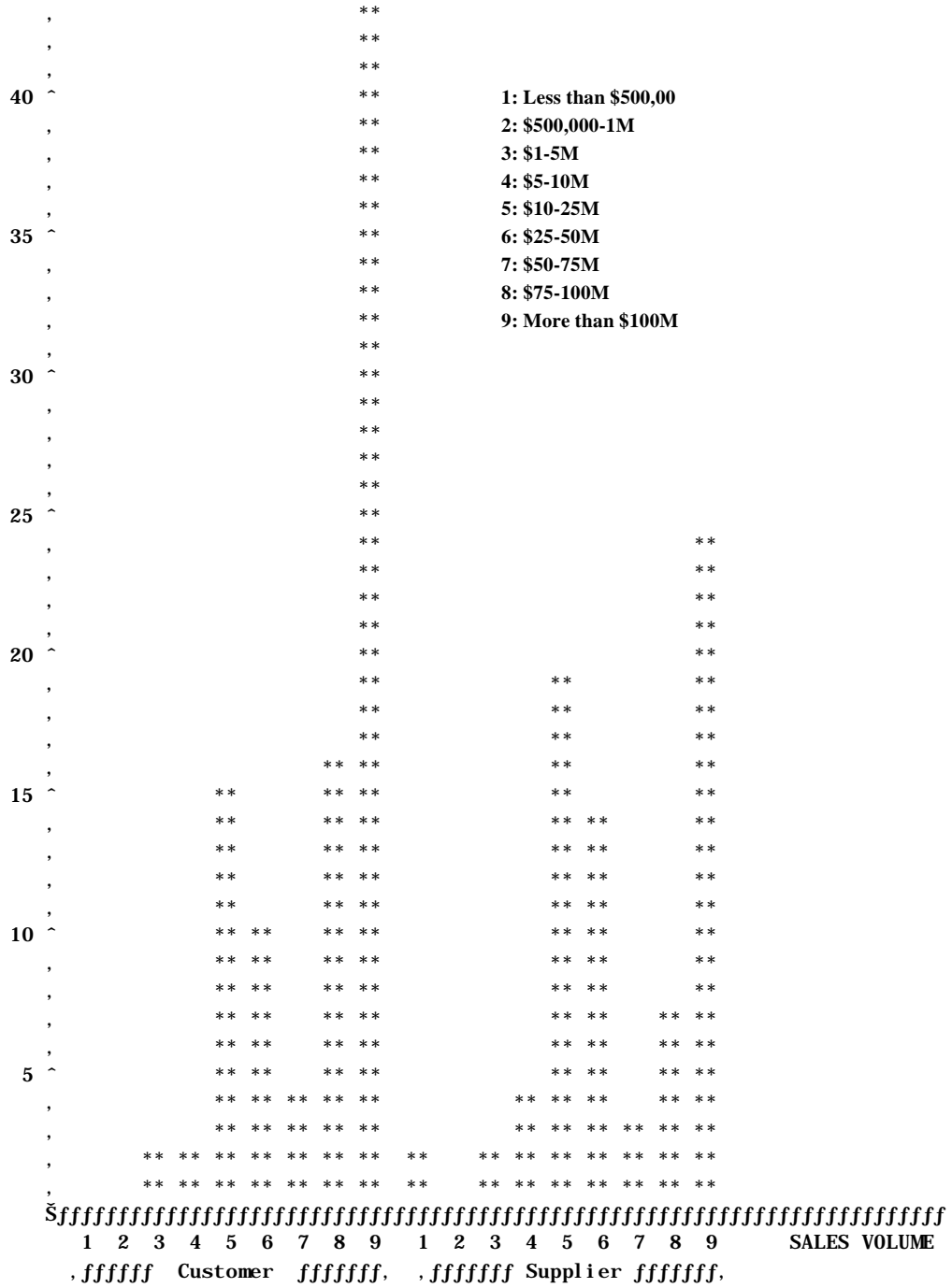
Figure 4-6. Histogram: Average Total Annual Sales Volume

Table 4-5. Participating Companies' Total Number of Employees

Frequency Row %	Less than 100	100 - 500	501 - 1000	1001 - 2500	2501 - 5000	5001 - 10000	10001 - 25000	25001 - 50000	More than 50000	Total
Customer	7	31	13	16	10	4	4	3	6	94
	7.45	32.98	13.83	17.02	10.64	4.26	4.26	3.19	6.38	
Supplier	9	37	8	8	8	2	1	2	3	78
	11.54	47.44	10.26	10.26	10.26	2.56	1.28	2.56	3.85	
Total	16	68	21	24	18	6	5	5	9	172

Fourth, to examine respondents' single vs. multiple sourcing situations, a question was asked as to whether or not the partner was a single source supplier or customer. More than 45% (42/93) of customer companies indicated that the partner was the single source supplier for parts or components, while 32% (25/78) of supplier companies indicated that the partner was the single source customer purchasing parts or components from them. This observation, combined with the findings in Table 4-3 that suppliers rely on long-term partnerships more than customers do, indicates that more suppliers appear to have business relationships with multiple source partners (customer) based on long-term relationships than customers do.

Fifth, the percentage of sales or purchasing that is accounted for by the partner is summarized in Figure 4-7. More than 75% of customers (62/82) indicated that less than 25% was purchased from the partner, whereas almost 69% of suppliers (51/74) indicated that the partner accounted for less than 35% of their sales.

Sixth, a question was asked to find out what proportion of each company's relationship with all customers or suppliers is considered a partnership as defined in the first question of Part I. A total of 159 people answered this question with an average of 36.47% (the customer perspective: 34.44% and the supplier perspective: 38.93%)

4.2 *Results for Research Question #1*

To answer the first research question: ***What joint tools and practices have been used by U.S. private manufacturing companies in q1-q3 joint action?***, the following three points were addressed using data collected from survey Items #45 and 46 with

```
                                                       Cum.              Cum.
         Midpoint                              Freq    Freq   Percent   Percent
                 ,
Customer    5 ,**********************************   36     36    23.08    23.08
           15 ,************************            26     62    16.67    39.74
           25 ,****                                 4     66     2.56    42.31
           35 ,****                                 4     70     2.56    44.87
           45 ,**                                   2     72     1.28    46.15
           55 ,**                                   2     74     1.28    47.44
           65 ,*                                    1     75     0.64    48.08
           75 ,***                                  3     78     1.92    50.00
           85 ,**                                   2     80     1.28    51.28
           95 ,**                                   2     82     1.28    52.56
                 ,
Supplier    5 ,*****************                   18    100    11.54    64.10
           15 ,********************                21    121    13.46    77.56
           25 ,************                        12    133     7.69    85.26
           35 ,******                               6    139     3.85    89.10
           45 ,***                                  3    142     1.92    91.0
           55 ,****                                 4    146     2.56    93.59
           65 ,*****                                5    151     3.21    96.79
           75 ,*                                    1    152     0.64    97.44
           85 ,***                                  3    155     1.92    99.36
           95 ,*                                    1    156     0.64   100.00
                 ,
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                  5    10    15    20    25    30    35    Frequency
```

Figure 4-7. Distribution of Percentage of Sales To or Purchasing From the Partner

respect to three groups – customers, suppliers, and overall (see Appendix C for item wording):

- First, an average number of tools/joint practices for each perspective was calculated,
- Second, the number of tools/joint practices checked (in Item #45) and listed (in Item #46) was calculated to determine how many U.S. private manufacturing companies have used how many tools/joint practices in their q1-q3 relationship, and
- Third, the frequency of each tool/joint practice was examined to see which tools/joint practices have been used more *or* less frequently than others.

4.2.1   Results derived from the customer perspective

Of the 94 respondents who took the customer perspective, 93 respondents identified 861 tools/joint practices (823 checked from list in Item #45 and 38 additional

tools/joint practices listed in Item #46). This resulted in an average of 9.3 tools/joint practices (861/93) used in q1-q3 joint action from the customer perspective. Also, the following two results were derived from the number of tools/joint practices checked and listed by each respondent.
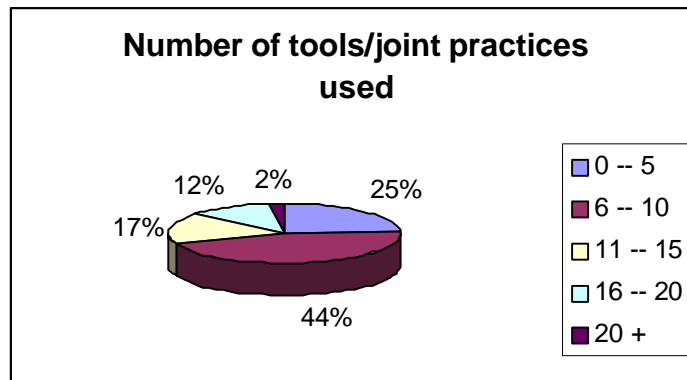
0-5: 23 (25%)   6-10: 41 (44%)   11-15: 16 (17%)   16-20: 11 (12%)   20+: 2 (2%)

Figure 4-8. Number of Tools/Joint Practices Used[1] (From the Customer Perspective)

```
Number of tools/joint practices

                                                              Cum.            Cum.
Midpoint                                           Freq   Freq   Per      Per
   0  ,                                               0      0   0.00     0.00
   2  ,****                                           2      2   2.15     2.15
   4  ,******************                             9     11   9.68    11.83
   6  ,*************************************************  25     36  26.88    38.71
   8  ,***********************                         12     48  12.90    51.61
  10  ,*******************************                 16     64  17.20    68.82
  12  ,**********************                          11     75  11.83    80.65
  14  ,**                                              1     76   1.08    81.72
  16  ,**********                                      5     81   5.38    87.10
  18  ,*****************                               9     90   9.68    96.77
  20  ,**                                              1     91   1.08    97.85
  22  ,**                                              1     92   1.08    98.92
  24  ,**                                              1     93   1.08   100.00
      Šƒƒƒ^ƒƒƒ^ƒƒƒ^ƒƒƒ^ƒƒƒ^ƒƒƒ^ƒƒƒ^ƒƒƒ^ƒƒƒ^ƒƒƒ^ƒƒƒ^ƒƒƒ^ƒƒ
         2    4    6    8   10   12   14   16   18   20   22   24   Frequency
```

**Figure 4-9. Distribution of Number of Tools/Joint Practices
(From the Customer Perspective)**

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[1] Mailed survey respondents were not asked to provide data in this format – i.e., they were not asked to provide a range of tools/joint practices used. Five categories of the number of tools/joint practices (0-5, 6-10, 11-15, 16-20, and 20+) were chosen by the researcher after data collection to produce results shown in Figure 4-8.

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According to Figure 4-8, almost 70% respondents indicate that they have used 0-10 tools/joint practices. This is also confirmed in Figure 4-9 in which the range between 5 and 11 was the most heavily distributed range in terms of the number of tools/joint practices used.

Next, to see which tools/joint practices have been used more *or* less frequently than others, the frequency of each tool/joint practice checked in Item #45 was examined and Table 4-6 and Figure 4-10 show the results.

Table 4-6. Frequency of Tools/Joint Practices Identified
(From the Customer Perspective)

(Only the tools/joint practices identified in Item #45 were used.)

Tools/joint practices	Frequency (# of times checked)	%	Ranking	Tools/joint practices	Frequency (# of times checked)	%	Ranking
1: Benchmarking	38	4.6	10	10: Joint problem-solving teams	72	8.7	2
2: Cost of quality	30	3.6	13	11: Joint planning	62	7.5	6
3: Gainsharing	19	2.3	16	12: Exchange of strategic information	59	7.2	7
4: JIT delivery/production	66	8.0	4	13: Quality audit	70	8.5	3
5: Quality circles	17	2.1	17	14: Joint investment on R&D	26	3.2	15
6: Quality Function Deployment	16	1.9	18	15: In-plant representative	31	3.8	12
7: Statistical process control	55	6.7	9	16: Supplier or customer performance measurement system	63	7.7	5
8: Supplier certification/verifica-tion	78	9.5	1	17: ISO 9000 and/or QS 9000 and/or Baldrige criteria	59	7.2	7
9: Joint quality education/training	30	3.6	13	18: Dynamic control tools (e.g., flow diagram, FMEA)	32	3.9	11

From Table 4-6 and Figure 4-10, the most and least frequently used tools/joint practices were identified as follows:

• The 5 most frequently used tools/joint practices: supplier certification/verification, joint problem-solving teams, quality audit, JIT delivery/production, and supplier or customer performance measurement system; and

# of respondents checking the tools/joint practices

Rankings: Names of tools/joint practices (Tool/joint practice numberings used in survey Item #45)
#1: Supplier certification/verification (8)   #2: Joint problem-solving teams (10)   #3: Quality audit (13)
#4: JIT delivery/production (4)   #5: Supplier or customer performance measurement system (16)
#6: Joint planning (11)
#7 & 8: Exchange of strategic information (12) & ISO 9000 and/or QS 9000 and/or Baldrige criteria (17)
#9: Statistical process control (7)   #10: Benchmarking (1)   #11: Dynamic control tools (18)
#12: In-plant representatives (15)   #13 & 14: Cost of quality (2) & Joint quality education/training (9)
#15: Joint investment on R & D (14)   #16: Gainsharing (3)   #17: Quality circles (5)
#18: Quality Function Deployment (6)

Figure 4-10. Frequency of Tools/Joint Practices Identified
(From the Customer Perspective)

- The 6 least frequently used tools/joint practices: quality function deployment, quality
  circles, gainsharing, joint investment on R&D, cost of quality, and joint quality
  education/training.

   In addition to the tools/joint practices listed to be checked by respondents in Item
#45, 25 respondents identified 38 additional tools/joint practices in Item #46. Figure 4-
11 lists these 38 additional tools/joint practices. Many of the tools/joint practices in
Figure 4-11 seemed similar to, but not exactly the same as, tools/joint practices in the
survey (e.g., the Kanban system related to JIT delivery/production). However, without
more information on these tools/joint practices, the researcher was reluctant to attempt to
combine them with pre-specified tools/joint practices[2]. No strong themes emerged in

---

[2] Therefore, both tools/joint practices checked in survey Item #45 and listed in survey Item #46 were used
to calculate the average number of tools/joint practices used by each perspective.

looking at additional tools/joint practices, which provided some evidence that the list of eighteen pre-specified tools/joint practices seemed to capture the major tools/joint practices being used in the sample.

Vendor's knowledge of process training our engineers	Documented part/process quality agreement (contracts)
Continuous improvement business plan	Design guidelines (worked out with the supplier)
Electronic order & schedule sharing & placement	Corrective action documentation & process for validation
Warranty failure review meeting	Quality operating systems
Kanban system	Quality advancement task force
Vendor managed stocking programs	Process certification
Advanced quality planning	Supplier, sub-contractor training
Part qualification	Quality action teams
Cycle time reduction	Quality business reviews
Design reviews	Early supplier involvement in new designs
Yield improvement	Product test development
Measuring systems	Mentor
Manufacturability review	Golf-to-build relationship
Demerit audits	Shared systems (virtual warehouse)
Customer/supplier survey	Joint analysis of returns
Value analysis	Employee empowerment program
Kaizen	Personal meeting (non-business)
Quality technical personal interface with suppliers	Consignment inventory
Process/product document change notification and control process	New product introduction (early supplier involvement on design, test, and manufacturing)

Figure 4-11. Additional Tools/Joint Practices Identified By Customers

4.2.2   Results derived from the supplier perspective

The same steps and procedures used in Section 4.2.1 were used to address three points: (1) the average number of tools/joint practices, (2) how many U.S. private manufacturing companies have used how many tools/joint practices in their q1-q3 relationship, and (3) the frequency of each tool/joint practice from the supplier perspective.

Seventy-six out of 78 respondents who took the supplier perspective identified 675 tools/joint practices (649 checked in Item #45 and 26 listed in Item #46) resulting in an average of 8.9 tools/joint practices (675/76) used in q1-q3 joint action from the supplier perspective. The data were also used to examine how many tools/joint practices have been used by how many respondents or companies. Figures 4-12 and 4-13 show the results.

Number of tools/joint practices used

Legend:
- 0 -- 5
- 6 -- 10
- 11 -- 15
- 16 -- 20
- 20+

7% 1%   24%
24%
44%
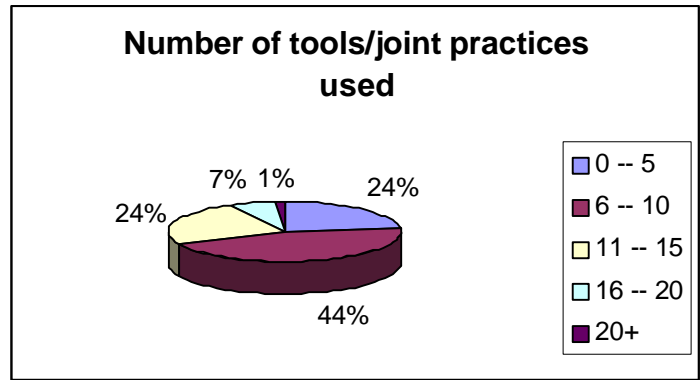
0-5: 18 (24%)   6-10: 34 (44%)   11-15: 18 (24%)   16-20: 5 (7%)   20+: 1 (1%)

Figure 4-12. Number of Tools/Joint Practices Used (From the Supplier Perspective)

NUMBER of tools/joint practices

		Freq	Cum. Freq	Percent	Cum. Per
Midpoint					
0	,	0	0	0. 00	0. 00
2	,********	4	4	5. 26	5. 26
4	,****	2	6	2. 63	7. 89
6	,**************************************	19	25	25. 00	32. 89
8	,******************************	15	40	19. 74	52. 63
10	,******************	9	49	11. 84	64. 47
12	,********************************	16	65	21. 05	85. 53
14	,******	3	68	3. 95	89. 47
16	,****	2	70	2. 63	92. 11
18	,******	3	73	3. 95	96. 05
20	,****	2	75	2. 63	98. 68
22	,**	1	76	1. 32	100. 00

Šƒƒƒ^ƒƒƒ^ƒƒƒ^ƒƒƒ^ƒƒƒ^ƒƒƒ^ƒƒƒ^ƒƒƒ^ƒƒƒ^ƒƒ
   2   4   6   8   10   12   14   16   18   Frequency

Figure 4-13. Distribution of Number of Tools/Joint Practices
(From the Supplier Perspective)

The overall pattern in Figures 4-12 and 4-13 are similar to that shown in Figures
4-8 and 4-9 except for two of the ranges of the number of tools/joint practices: 11-15 and
16-20. Seventeen percent and 24% of customers and suppliers indicated that they have
used 11-15 tools/joint practices, while 12% and 7% of customers and suppliers indicated
that they have used 16-20 tools/joint practices (see Figures 4-8 and 4-12).

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Next, the frequency of each tool/joint practice checked in Item #45 was examined to see which tools/joint practices have been used more *or* less frequently than others. Table 4-7 and Figure 4-14 show the results.

From Table 4-7 and Figure 4-14, the most and least frequently used tools/joint practices were identified as follows:

- The 6 most frequently used tools/joint practices: supplier certification/verification, joint problem-solving teams, statistical process control, JIT delivery/production, joint planning, and quality audit, and;
- The 5 least frequently used tools/joint practices: quality circles, gainsharing, quality function deployment, in-plant representative, and joint investment on R&D.

Table 4-7. Frequency of Tools/Joint Practices Identified
(From the Supplier Perspective)

(Only the tools/joint practices identified in Item #45 were used.)

Tools/joint practices	Frequency (# of times checked)	%	Ranking	Tools/joint practices	Frequency (# of times checked)	%	Ranking
1: Benchmarking	33	5.1	11	10: Joint problem-solving teams	52	8.0	2
2: Cost of quality	29	4.5	13	11: Joint planning	48	7.4	4
3: Gainsharing	11	1.7	17	12: Exchange of strategic information	42	6.5	9
4: JIT delivery/production	48	7.4	4	13: Quality audit	48	7.4	4
5: Quality circles	10	1.5	18	14: Joint investment on R&D	23	3.5	14
6: Quality Function Deployment	17	2.6	16	15: In-plant representative	18	2.8	15
7: Statistical process control	49	7.6	3	16: Supplier or customer performance measurement system	45	6.9	8
8: Supplier certification/verifica-tion	60	9.2	1	17: ISO 9000 and/or QS 9000 and/or Baldrige criteria	47	7.2	7
9: Joint quality education/training	33	5.1	11	18: Dynamic control tools (e.g., flow diagram, FMEA)	36	5.5	10
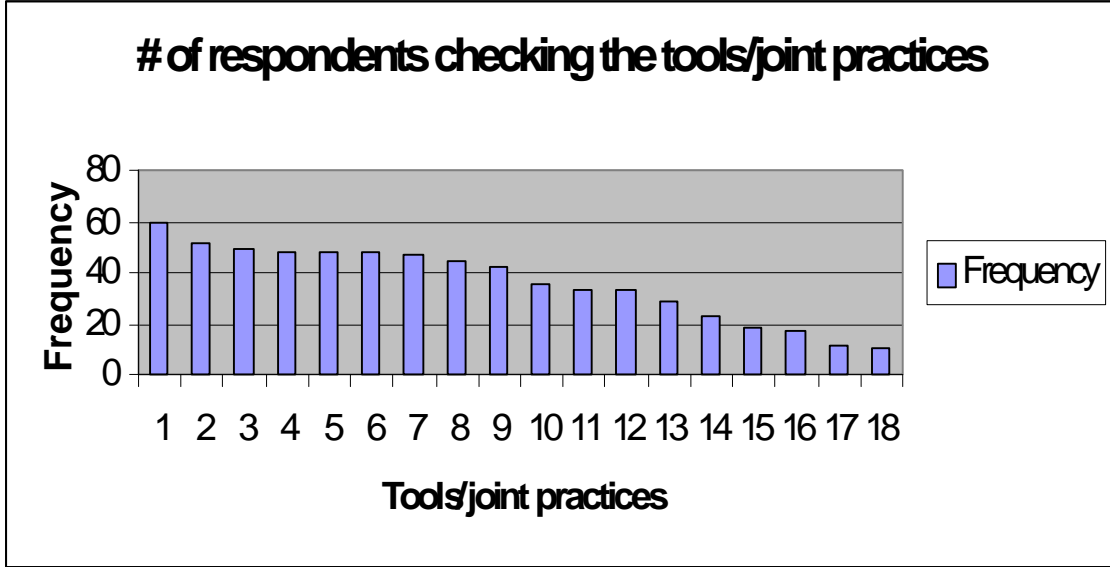
of respondents checking the tools/joint practices

Rankings: Names of tools/joint practices (Tool/joint practice numberings used in survey Item #45)
#1: Supplier certification/verification (8)   #2: Joint problem-solving teams (10)   #3: Statistical process control (7)
4, 5 & 6: JIT delivery/production (4), Joint planning (11), and Quality audit (13)
#7: ISO 9000 and/or QS 9000 and/or Baldrige criteria (17)
#8: Supplier or customer performance measurement system (16)
#9: Exchange of strategic information (12)   #10: Dynamic control tools (18)
#11 & 12: Joint quality education/training (9) and Benchmarking (1)   #13: Cost of quality (2)
#14: Joint investment on R & D (14)   #15: In-plant representative (15)
#16: Quality Function Deployment (6)   #17: Gainsharing (3)   #18: Quality circles (5)

**Figure 4-14. Frequency of Tools/Joint Practices Identified
(From the Supplier Perspective)**

In addition to the tools/joint practices provided in Item #45, 15 respondents identified 26 additional tools/joint practices in Item #46. Figure 4-15 lists these 26 additional tools/joint practices.

Electronic Data Interchange (2 responses)	Delivery to line sequence	Strategic material purchasing
Volume variable price structure	Joint marketing programs	Business strategic planning
On-time delivery	Regular face-to-face meetings	Value engineering
Corrective action procedures	Source inspection	Kaizen
TCO (Total Cost of Ownership) modeling	Total productive maintenance	Cost reduction
Responsiveness to technical issues	Sharing unusual costs	Price negotiation
Resolving documentation issues	Bar-coding dominated pick ups	Status updates
Internal access to customers' web sites	electronic source inspection	
East/west coast weekly technical review via Telecom	Production part approval process / Sample inspection report	

Figure 4-15. Additional Tools/Joint Practices Identified By Suppliers

This result is similar to that found in the customer perspective. In other words, most tools/joint practices additionally identified in Figure 4-15 seemed to relate to pre-specified tools/joint practices in the survey without significant differences. For example, business strategic planning related to joint planning, on-time delivery to JIT delivery, sharing unusual costs to exchange of strategic information, and so on. Therefore no attempt to combine them with pre-specified tools/joint practices was made by the researcher.

4.2.3 Results derived from the overall perspective

Results presented in Sections 4.2.1 and 4.2.2 were combined to address the same three points from the overall perspective: (1) the average number of tools/joint practices, (2)) how many U.S. private manufacturing companies have used how many tools/joint practices in their q1-q3 relationship, and (3) the frequency of each tool/joint practice.

- Average number of tools/joint practices used: $(861 + 675) / (93 + 76) = 9.1$.
- Number of tools/joint practices used:
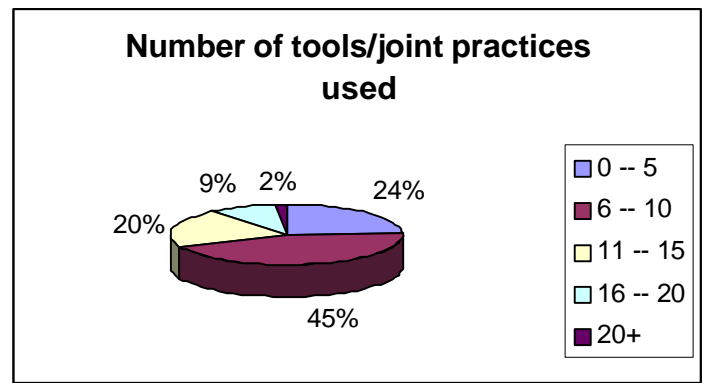
0-5: 41 (24%)   6-10: 75 (45%)   11-15: 34 (20%)   16-20: 16 (9%)   20+: 3 (2%)

Figure 4-16. Number of Tools/Joint Practices Used (From the Overall Perspective)

- Overall distribution of the number of tools/joint practices:

```
NUMBER of tools/joint practices

                                                          Cum.              Cum.
   Midpoint                                        Freq   Freq   Percent   Percent

    0  ,                                              0      0    0.00      0.00
    2  ,******                                        6      6    3.55      3.55
    4  ,***********                                  11     17    6.51     10.06
    6  ,********************************************  44     61   26.04     36.09
    8  ,*************************                    27     88   15.98     52.07
   10  ,***********************                      25    113   14.79     66.86
   12  ,*************************                    27    140   15.98     82.84
   14  ,****                                          4    144    2.37     85.21
   16  ,*******                                       7    151    4.14     89.35
   18  ,*************                                13    164    7.69     97.04
   20  ,**                                            2    166    1.18     98.22
   22  ,**                                            2    168    1.18     99.41
   24  ,*                                             1    169    0.59    100.00
       Šƒƒƒƒ^ƒƒƒƒ^ƒƒƒƒ^ƒƒƒƒ^ƒƒƒƒ^ƒƒƒƒ^ƒƒƒƒ^ƒƒƒƒ^ƒƒƒƒ
           5    10   15   20   25   30   35   40    Frequency
```

Figure 4-17. Overall Distribution of the Number of Tools/Joint Practices

- The 5 most frequently used tools/joint practices (see Table 4-8 and Figure 4-18): supplier certification/verification, joint problem-solving teams, quality audit, JIT delivery/production, and joint planning; and

- The 5 least frequently used tools/joint practices (see Table 4-8 and Figure 4-18): quality circles, gainsharing, quality function deployment, joint investment on R&D, and in-plant representative.

Table 4-8. Frequency of Tools/Joint Practices Identified
(From the Overall Perspective)

(Only 1,472 tools/joint practices identified in Item #45 were used.)

Tools/joint practices	Frequency (# of times checked)	%	Ranking	Tools/joint practices	Frequency (# of times checked)	%	Ranking
1: Benchmarking	71	4.8	10	10: Joint problem-solving teams	124	8.4	2
2: Cost of quality	59	4.0	13	11: Joint planning	110	7.5	5
3: Gainsharing	30	2.0	17	12: Exchange of strategic information	101	6.9	9
4: JIT delivery/production	114	7.7	4	13: Quality audit	118	8.0	3
5: Quality circles	27	1.8	18	14: Joint investment on R&D	49	3.3	14
6: Quality Function Deployment	33	2.2	16	15: In-plant representative	49	3.3	14
7: Statistical process control	104	7.1	8	16: Supplier or customer performance measurement system	108	7.3	6
8: Supplier certification/verifica-tion	138	9.4	1	17: ISO 9000 and/or QS 9000 and/or Baldrige criteria	106	7.2	7
9: Joint quality education/training	63	4.3	12	18: Dynamic control tools (e.g., flow diagram, FMEA)	68	4.6	11
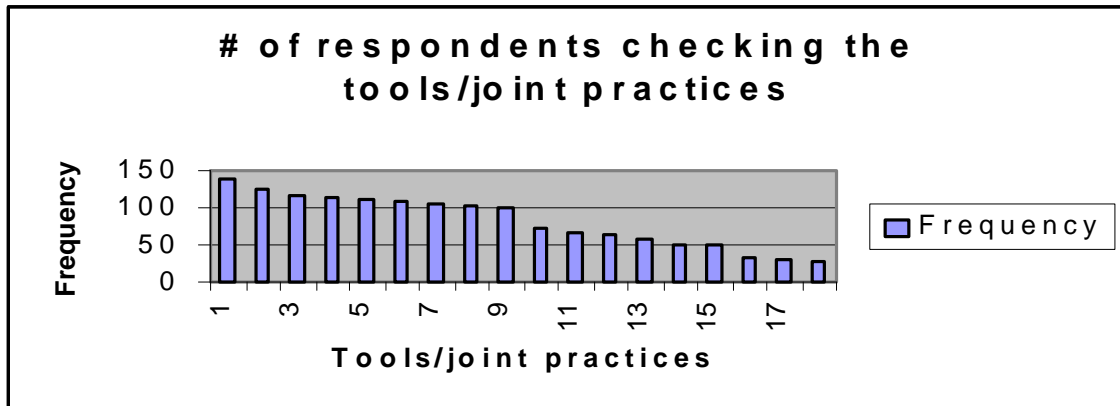
Rankings: Names of tools/joint practices (Tool/joint practice numberings used in survey Item #45)
#1: Supplier certification/verification (8)   #2: Joint problem-solving teams (10)   #3: Quality audit (13)
#4: JIT delivery/production (4)   #5: Joint planning (11)
#6: Supplier or customer performance measurement system (16)
#7: ISO 9000 and/or QS 9000 and/or Baldrige criteria (17)   #8: Statistical process control (7)
#9: Exchange of strategic information (12)   #10: Benchmarking (1)   #11: Dynamic control tools (18)
#12: Joint quality education/training (9)   #13: Cost of quality (2)
#14 & 15: Joint investment on R & D (14) and In-plant representative (15)   #16: Quality Function Deployment (6)
#17: Gainsharing (3)   #18: Quality circles (5)

Figure 4-18. Frequency of Tools/Joint Practices Identified
(From the Overall Perspective)

4.2.4 Summary results for research question #1

This section summarizes results presented in Sections 4.2.1 through 4.2.3 by combining those results to derive additional findings. Table 4-9 shows all key results and answers to the first research question. Some findings that can be derived from Table 4-9 as well as from previous tables and figures are:

Table 4-9. Summary of Key Results and Answers to Research Question #1

	Customer perspective	Supplier perspective	Overall
Number of tools/joint practiced identified	861	675	1,536
Number of respondents	93	76	169
Average number of tools/joint practices used	9.3 (Std Dev: 4.92)	8.9 (Std Dev: 4.25)	9.1 (Std Dev: 4.62)
Two ranges of number of tools/joint practices received highest vote	6-10 (44%) 0-5 (25%)	6-10 (44%) 0-5 & 11-15 (24%)	6-10 (45%) 0-5 (24%)
Most frequently used tools/joint practices	8. Supplier certification/verification (9.5%), 10. Joint problem-solving teams (8.7%), 13. Quality audit (8.5%), 4. JIT delivery/production 8.0%), and 16. Supplier or customer performance measurement system (7.7%)	8. Supplier certification/verification (9.2%), 10. Joint problem-solving teams (8.0%), 7. Statistical process control (7.6%), 11. Joint planning (7.4%), & 13. Quality audit (7.4%), and 4. JIT delivery/ production (7.4%)	8. Supplier certification/verification (9.4%), 10. Joint problem-solving teams (8.4%), 13. Quality audit (8.0%), 4. JIT delivery/production (7.7%), and 11. Joint planning (7.5%)
Least frequently used tools/joint practices	6. Quality Function Deployment (1.9%), 5. Quality circles (2.1%), 3. Gainsharing (2.3%), 14. Joint investment on R&D (3.2%), 2. Cost of quality (3.6%), and 9. Joint quality education/training (3.6%)	5. Quality circles (1.5%), 3. Gainsharing (1.7%), 6. Quality Function Deployment (2.6%), 15. In-plant representative (2.8%), and 14. Joint investment on R&D (3.5%)	5. Quality circles (1.8%), 3. Gainsharing (2.0%), 6. Quality Function Deployment (2.2%), 14. Joint investment on R&D (3.3%), and 15. In-plant representative (3.3%)

- First, there was a difference of 0.4 in the average number of tools/joint practices used between customers' and suppliers' responses.
- Second, regardless of perspectives, most participants responded that their organizations have used 6-10 tools/joint practices followed by 0-5.
- Third, 24% (18/76) suppliers reported that they have used 11-15 tools/joint practices in their q1-q3 relationships, while only 17% customers indicated that they have used

11-15 tools/joint practices in their relationship with suppliers (see Figures 4-8 and 4-12).

- Fourth, almost 80% of supplier responses were distributed between numbers 5 and 13 of the tool/joint practice-range, whereas less than 70% of customer responses are distributed in the same range (see Figures 4-9 and 4-13).

- Fifth, regardless of perspectives, four tools/joint practices have been identified as the most and least frequently used. They are:

> Four most frequently used tools/joint practices:
>
> > **Supplier certification and verification,**
> > **Joint problem-solving teams,**
> > **Quality audits, and**
> > **Just-In-Time production and delivery.**
>
> Four least frequently used tools/joint practices:
>
> > **Quality circles,**
> > **Gainsharing,**
> > **Quality Function Deployment (QFD), and**
> > **Joint investment on R & D.**

This finding is supported by results from structured interviews. Five out of seven interviewees indicated that they have used supplier certification/verification, joint problem-solving teams, and quality audit. Other tools/joint practices identified by the five interviewees include joint planning, exchange of strategic information, and a supplier or customer performance measurement system.

- Sixth, some additional tools/joint practices identified more than twice (in Item #46) were Electronic Data Interchange (EDI; or electronic order & schedule sharing & placement), face-to-face personal meetings, and different forms of joint practices that were aimed at improving quality such as a quality advanced task force, advanced quality planning, and quality action teams.

4.2.5 Additional results related to Research Question #1 and organizational profile

In Sections 4.1 and 4.2, the following three points were identified:

- The average number of tools/joint practices identified by the customer and supplier perspectives were 9.3 and 8.9 respectively;

- More than 68% of the organization's average total annual sales volume for customer perspective was over $50 million, while only 45% of the supplier organizations fell into the same category; and

- Eighteen and 10 % of the customer and supplier organizations respectively have more than 5,000 employees.

To explore the difference of 0.4 tools/joint practices identified between the customer and supplier perspective, organizational size measured by the average total annual sales volume and number of employees was examined. Table 4-10 shows mean number of tools/joint practices used with respect to the above two organizational size measures.

Table 4-10. One-Way ANOVA[3]: Mean Number of Tools/Joint Practices with Respect to Two Organizational Size Measures

<div align="right">( ): Standard deviation</div>

Total annual sales volume	Less than $500,000	$500,000- 1 million	$1-5 million	$5-10 million	$10-25 million	$25-50 million	$50-75 million	$75-100 million	More than $100 million
μ (number of tools/joint practices used)	10.5 (0.71)	-- (--)	9.8 (4.57)	6.2 (2.93)	7.5 (4.26)	8.0 (3.98)	9.0 (4.62)	9.3 (4.51)	10.3 (4.83)
Total annual sales volume: df: 1 mean square: 167.90 F value: 8.43 p < 0.0042									
Number of employees	Less than 100	100-500	501- 1000	1001- 2500	2501- 5000	5001- 10,000	10,001- 25,000	25,001- 50,000	More than 50,000
μ (number of tools/joint practices used)	8.3 (3.84)	7.8 (4.13)	9.6 (4.74)	10.5 (4.87)	9.9 (4.69)	10.8 (5.12)	8.2 (3.77)	10.8 (6.69)	10.1 (4.54)
Number of employees: df: 1 mean square: 110.08 F value: 5.54 p < 0.0197									

It is observed from Table 4-10 that both objective measures of organizational size had no positive relationship with the mean number of tools/joint practices used at the significance levels 0.0042 and 0.0197. This is because the mean number of tools/joint practices does not consistently increase as the organizational size measures become bigger.

---

[3] One-way ANOVA was used because there was no significant combined effect from average total annual sales volume and number of employees on the number of tools/joint practices used in examining their relationship as shown below:
Combined effects: df: 1 mean square: 15.92 F value: 0.80 p < 0.3739.

4.3 Results for Research Question #2

To answer the second research question: ***Which tools and joint practices have been more effective and internalized in q1-q3 joint action?***, the steps and procedures introduced in Section 3.6.2 were followed and are reproduced below.

1. Using the 18 tools and joint practices listed in survey Item # 45, the actual scores for effectiveness and internalization of each tool and joint practice were used as input to Table 4-11. (The shaded area was completed with the actual scores from the mailed survey questionnaire.)
2. Using the actual scores, the mean values of each tool and joint practice – level of effectiveness and internalization – were calculated and are shown in the last row of the Table 4-11. (Internalization was defined in the survey as how much each tool and joint practice is institutionalized into the way each party does business with partners.)
3. Then, one-way ANOVA made a null hypothesis, $H_0 : \mu_{\text{Tool/joint practice 1}} = \mu_{\text{Tool/joint practice 2}} = \text{---} = \mu_{\text{Tool/joint practice 18}}$.
4. Based on the mean values in the last row, the null hypothesis was accepted or rejected by comparing the mean values in a pairwise fashion.
5. If the null hypothesis was accepted, the level of effectiveness and internalization of each tool and joint practice identified was thought to be the same. If, however, the null hypothesis was rejected, a multiple range test (or paired test) was conducted to group those tools and joint practices whose effectiveness and internalization levels fell into the same range.

Table 4-11. One-way ANOVA (Reproduced)

Joint Action	Tool/joint practice 1	Tool/joint practice 2	-----	Tool/joint practice 18
Actual Scores				
Mean (Level of effectiveness and/or internalization)	$\mu_{\text{Tool/joint practice 1}}$	$\mu_{\text{Tool/joint practice 2}}$	-----	$\mu_{\text{Tool/joint practice 18}}$

4.3.1 Results derived from the customer perspective

One-way ANOVA was used to see if the null hypothesis, $H_0 : \mu_{\text{Tool/joint practice 1}} = \mu_{\text{Tool/joint practice 2}} = \mu_{\text{-----}} = \mu_{\text{Tool/joint practice 18}}$ was supported. Table 4-12 shows the results.

As shown in Table 4-12, the null hypotheses for both effectiveness and internalization were not accepted, and therefore, Duncan's multiple range test was used to group those tools and joint practices whose effectiveness and internalization levels fell into the same range. Figures 4-19 and 4-20 show the results of multiple range test for the level of effectiveness and internalization respectively.

Table 4-12. Mean Values of Effectiveness and Internalization for Each Tool/Joint Practice (From the Customer Perspective)

Tools/joint practices	N	Effectiveness[*]		Internalization[*]	
		Mean	Std. Dev.	Mean	Std. Dev.
1: Benchmarking	38	4.34	0.91	3.79	1.23
2: Cost of quality	30	4.23	1.22	3.97	1.45
3: Gainsharing	19	3.89	1.70	3.95	1.61
4: JIT delivery/production	66	4.92	0.75	5.05	0.85
5: Quality circles	17	3.94	1.60	3.94	1.68
6: Quality Function Deployment	16	3.44	1.63	3.44	1.67
7: Statistical process control	55	4.67	1.12	4.53	1.29
8: Supplier certification/verification	78	4.67	0.89	4.73	1.00
9: Joint quality education/training	30	4.60	1.07	4.47	1.28
10: Joint problem-solving teams	72	4.85	0.82	4.86	0.77
11: Joint planning	62	4.87	0.74	4.77	0.93
12: Exchange of strategic information	59	4.64	1.01	4.63	1.07
13: Quality audit	70	4.94	0.74	5.03	0.92
14: Joint investment on R&D	26	4.46	1.61	4.42	1.63
15: In-plant representative	31	4.68	1.56	4.45	1.52
16: Supplier or customer performance measurement system	63	4.81	1.08	4.81	1.20
17: ISO 9000 and/or QS 9000 and/or Baldrige criteria	59	5.08	1.09	5.05	1.21
18: Dynamic control tools (e.g., flow diagram, FMEA)	72	4.59	1.29	4.16	1.57
Effectiveness: DF: 17 Mean square: 4.80 F value: 4.23 p < 0.0001					
Internalization: DF: 17 Mean square: 7.72 F value: 5.55 p < 0.0001					

*: Responses were on a six-point Likert-type scale ranging from 1 (Very Ineffective or Very Low Internalization) to 6 (Very Effective or Very High Internalization).

```
              Alpha= 0.05   df= 805   MSE= 1.133764
       Means with the same letter are not significantly different.
```

Duncan Grouping					Mean	N	# of Tool/joint practice
		A			5.0847	59	17
		A					
B		A			4.9429	70	13
B		A					
B		A			4.9242	66	4
B		A					
B		A			4.8710	62	11
B		A					
B		A			4.8472	72	10
B		A					
B		A		C	4.8095	63	16
B		A		C			
B		A		C	4.6774	31	15
B		A		C			
B		A		C	4.6727	55	7
B		A		C			
B		A		C	4.6667	78	8
B		A		C			
B		A		C	4.6441	59	12
B		A		C			
B		A		C	4.6000	30	9
B		A		C			
B		A		C	4.5938	32	18
B				C			
B			D	C	4.4615	26	14
B			D	C			
B	E		D	C	4.3421	38	1
	E		D	C			
	E		D	C	4.2333	30	2
	E		D				
F	E		D		3.9412	17	5
F	E						
F	E				3.8947	19	3
F							
F					3.4375	16	6

Figure 4-19. Duncan's Multiple Range Test: Effectiveness
(From the Customer Perspective)

In Figure 4-19, ISO 9000 and/or QS 9000 and/or Baldrige criteria is considered most effective (tool/joint practice #17 as indicated by the first two As). A group of tools/joint practices considered second most effective includes quality audit, JIT delivery/production, joint planning, and joint problem-solving teams. Using the same

Means with the same letter are not significantly different.

Duncan Grouping			Mean	N	# of Tool/joint practice
	A		5.0508	59	17
	A				
	A		5.0455	66	4
	A				
	A		5.0286	70	13
	A				
	A		4.8611	72	10
	A				
	A		4.8095	63	16
	A				
B	A		4.7742	62	11
B	A				
B	A		4.7308	78	8
B	A				
B	A		4.6271	59	12
B	A				
B	A	C	4.5273	55	7
B	A	C			
B	A	C	4.4667	30	9
B	A	C			
B	A	C	4.4516	31	15
B	A	C			
B	A	C	4.4231	26	14
B		C			
B	D	C	4.1563	32	18
	D	C			
E	D	C	3.9667	30	2
E	D	C			
E	D	C	3.9474	19	3
E	D	C			
E	D	C	3.9412	17	5
E	D				
E	D		3.7895	38	1
E					
E			3.4375	16	6

Figure 4-20. Duncan's Multiple Range Test: Internalization
(From the Customer Perspective)

logic, Figures 4-19 and 4-20 are summarized. Results are shown in Figure 4-21. It was observed that the difference in the level of effectiveness and internalization for adjacent tools and joint practices was not significant. The way each tool and joint practice is grouped in Figure 4-21 shows the order (descending) of effectiveness and internalization without considering the amount of difference in the level of effectiveness and

Most effective ↑	ISO 9000 and/or QS 9000 and/or Baldrige criteria (17)
	Quality audit (13), JIT delivery/production (4), Joint planning (11), Joint problem-solving teams (10)
	Supplier or customer performance measurement systems (16), In-plant representative (15), Statistical Process Control (7), Supplier certification or verification (8), Exchange of strategic information (12), Joint quality education/training (9), Dynamic control tools (18)
	Joint investment on R & D (14)
↓	Benchmarking (1), Cost of quality (2)
Least effective	Quality circles (5), Gainsharing (3), Quality function deployment (6)
Most internalized ↑	ISO 9000 and/or QS 9000 and/or Baldrige criteria (17), JIT delivery/production (4), Quality audit (13), Joint problem-solving teams (10), Supplier or customer performance measurement systems (16)
	Joint planning (11), Supplier certification or verification (8), Exchange of strategic information (12)
	Statistical Process Control (7), Joint quality education/training (9), In-plant representative (15), Joint investment on R & D (14)
↓	Dynamic control tools (18),
Least internalized	Cost of quality (2), Gainsharing (3), Quality circles (5), Benchmarking (1), Quality function deployment (6)

Figure 4-21. Summary Results of Effectiveness and Internalization of Each Tool/Joint Practice (From the Customer perspective)

internalization. However, it is also observed that the level of effectiveness and internalization for tools/joint practices in the first (and second) group is significantly higher than those in the last (and second last) group. In other words, it is safe to conclude that the tools/joint practices in the first (and second) group have been used more effectively and have been more internalized than those in the last (and second last) group.

4.3.2   Results derived from supplier perspective

The same steps and procedures were used to examine the levels of effectiveness and internalization of each tool/joint practice using suppliers' responses. Table 4-13, Figures 4-22 and 4-23 show the results.

As shown in Table 4-13, the null hypotheses of equal mean values for both effectiveness and internalization were not accepted, and therefore, Duncan's multiple range test was used. Figures 4-22 and 4-23 show the results.

Table 4-13. Mean Values of Effectiveness and Internalization for Each Tool/Joint Practice (From the Supplier Perspective)

Tools/joint practices	N	Effectiveness[*]		Internalization[*]	
		Mean	Std. Dev.	Mean	Std. Dev.
1: Benchmarking	33	4.15	1.28	3.61	1.34
2: Cost of quality	29	3.90	1.32	3.97	1.40
3: Gainsharing	11	3.91	1.51	3.91	1.51
4: JIT delivery/production	48	4.94	1.00	4.92	0.94
5: Quality circles	10	3.90	1.60	3.60	1.51
6: Quality Function Deployment	17	4.18	1.24	3.94	1.25
7: Statistical process control	49	4.49	1.28	4.31	1.43
8: Supplier certification/verification	60	4.70	1.11	4.58	1.34
9: Joint quality education/training	33	4.18	1.29	4.12	1.32
10: Joint problem-solving teams	52	4.71	1.21	4.44	1.27
11: Joint planning	48	4.75	1.10	4.50	1.32
12: Exchange of strategic information	42	4.33	1.14	4.21	1.22
13: Quality audit	48	4.94	0.84	4.79	0.90
14: Joint investment on R&D	23	4.00	1.60	3.74	1.51
15: In-plant representative	18	4.33	1.53	4.20	1.86
16: Supplier or customer performance measurement system	45	4.62	1.15	4.78	1.18
17: ISO 9000 and/or QS 9000 and/or Baldrige criteria	47	4.91	1.27	4.70	1.35
18: Dynamic control tools (e.g., flow diagram, FMEA)	36	4.31	1.39	4.36	1.38
Effectiveness: DF: 17 Mean square: 4.14			F value: 2.79	$p < 0.0002$	
Internalization: DF: 17 Mean square: 5.14			F value: 3.04	$p < 0.0001$	

*: Responses were on a six-point Likert-type scale ranging from 1 (Very Ineffective or Very Low Internalization) to 6 (Very Effective or Very High Internalization).

The same phenomenon is observed from the suppliers' responses. There was no significant difference in the level of effectiveness and internalization between adjacent tools and joint practices. However, the level of effectiveness and internalization for tools/joint practices in the first (and second) group is significantly higher than those in the last (and second last) group. From Figures 4-22 and 4-23, summary results are derived and are shown in Figure 4-24.

```
           Alpha= 0.05   df= 631   MSE= 1.482525
 Means with the same letter are not significantly different.
   Duncan Grouping                     Mean      N    # of Tool/
                                                       joint practice


                         A              4.9375    48   13
                         A
                         A              4.9375    48   4
                         A
                         A              4.9149    47   17
                         A
              B          A              4.7500    48   11
              B          A
              B          A              4.7115    52   10
              B          A
              B          A              4.7000    60   8
              B          A
              B          A   C          4.6222    45   16
              B          A   C
              B          A   C          4.4898    49   7
              B          A   C
              B          A   C          4.3333    18   15
              B          A   C
              B          A   C          4.3333    42   12
              B          A   C
              B          A   C          4.3056    36   18
              B          A   C
              B          A   C          4.1818    33   9
              B          A   C
              B          A   C          4.1765    17   6
              B          A   C
              B          A   C          4.1515    33   1
              B              C
              B              C          4.0000    23   14
                             C
                             C          3.9091    11   3
                             C
                             C          3.9000    10   5
                             C
                             C          3.8966    29   2
```

Figure 4-22. Duncan's Multiple Range Test: Effectiveness (From the Supplier Perspective)

```
          Alpha= 0.05   df= 631   MSE= 1.69341
  Means with the same letter are not significantly different.
   Duncan Grouping                      Mean      N   # of Tool/
                                                         joint practice

                        A                4.9167   48   4
                        A
              B         A                4.7917   48   13
              B         A
              B         A                4.7778   45   16
              B         A
              B         A   C            4.7021   47   17
              B         A   C
              B         A   C            4.5833   60   8
              B         A   C
              B    D    A   C            4.5000   48   11
              B    D    A   C
              B    D    A   C            4.4423   52   10
              B    D    A   C
         E    B    D    A   C            4.3611   36   18
         E    B    D    A   C
         E    B    D    A   C            4.3061   49   7
         E    B    D    A   C
         E    B    D    A   C            4.2222   18   15
         E    B    D    A   C
         E    B    D    A   C            4.2143   42   12
         E    B    D    A   C
         E    B    D    A   C            4.1212   33   9
         E    B    D        C
         E    B    D        C            3.9655   29   2
         E         D        C
         E         D        C            3.9412   17   6
         E         D        C
         E         D        C            3.9091   11   3
         E         D
         E         D                     3.7391   23   14
         E
         E                               3.6061   33   1
         E
          E                              3.6000   10   5
```

Figure 4-23. Duncan's Multiple Range Test: Internalization
(From the Supplier Perspective)

Most effective ↑	Quality audit (13), JIT delivery/production (4), ISO 9000 and/or QS 9000 and/or Baldrige criteria (17)
	Joint planning (11), Joint problem-solving team (10), Supplier certification or verification (8)
↓ Least effective	Supplier or customer performance measurement system (16), Statistical process control (7), In-plant representative (15), Exchange of strategic information (12), Dynamic control tools (18), Joint quality education/training (9), Quality function deployment (6), Benchmarking (1), Joint investment on R & D (14), Gainsharing (3), Quality circles (5), Cost of quality (2)
Most internalized ↑	JIT delivery/production (4)
	Quality audit (13), Supplier or customer performance measurement system (16)
	ISO 9000 and/or QS 9000 and/or Baldrige criteria (17), Supplier certification or verification (8)
	Joint planning (11), Joint problem-solving team (10)
↓ Least internalized	Dynamic control tools (18), Statistical process control (7), In-plant representative (15), Exchange of strategic information (12), Joint quality education/training (9), Cost of quality (2), Quality function deployment (6), Gainsharing (3), Joint investment on R & D (14), Benchmarking (1), Quality circles (5)

Figure 4-24. Summary Results of Effectiveness and Internalization of Each Tool/Joint Practice (From the Supplier Perspective)

4.3.3 Results derived from the overall perspective

Using both customers' and suppliers' responses, the overall levels of effectiveness and internationalization of each tool/joint practice were obtained. Table 4-14 and Figures 4-25 through 4-27 show the results.

Table 4-14. Mean Values of Effectiveness and Internalization for Each Tool/Joint Practice (From the Overall Perspective)

Tools/joint practices	N	Effectiveness[*]		Internalization[*]	
		Mean	Std. Dev.	Mean	Std. Dev.
1: Benchmarking	71	4.25	1.09	3.70	1.29
2: Cost of quality	59	4.07	1.27	3.97	1.41
3: Gainsharing	30	3.90	1.60	3.93	1.55
4: JIT delivery/production	114	4.93	0.86	4.99	0.89
5: Quality circles	27	3.93	1.57	3.81	1.59
6: Quality Function Deployment	33	3.82	1.47	3.70	1.47
7: Statistical process control	104	4.59	1.20	4.42	1.36
8: Supplier certification/verification	138	4.68	0.99	4.67	1.61
9: Joint quality education/training	63	4.38	1.20	4.29	1.30
10: Joint problem-solving teams	124	4.79	1.00	4.69	1.03
11: Joint planning	110	4.82	0.91	4.65	1.12
12: Exchange of strategic information	101	4.51	1.07	4.46	1.14
13: Quality audit	118	4.94	0.78	4.93	0.91
14: Joint investment on R&D	49	4.24	1.60	4.10	1.60
15: In-plant representative	49	4.55	1.54	4.37	1.64
16: Supplier or customer performance measurement system	108	4.73	1.11	4.80	1.19
17: ISO 9000 and/or QS 9000 and/or Baldrige criteria	106	5.01	1.17	4.90	1.28
18: Dynamic control tools (e.g., flow diagram, FMEA)	108	4.44	1.34	4.26	1.46
Effectiveness: DF: 17 Mean square: 8.25 F value: 6.42 $p < 0.0001$					
Internalization: DF: 17 Mean square: 12.20 F value: 7.99 $p < 0.0001$					

*: Responses were on a six-point Likert-type scale ranging from 1 (Very Ineffective or Very Low Internalization) to 6 (Very Effective or Very High Internalization).

4.3.4   Summary results for research question #2

This section summarizes results presented in Sections 4.3.1 through 4.3.3 by combining them to derive additional findings. Table 4-15 and Figure 4-30 summarizes the key results for the second research question.

Means with the same letter are not significantly different.

Duncan Grouping				Mean	N	# of Tool / joint practice
		A		5.0094	106	17
		A				
B		A		4.9407	118	13
B		A				
B		A		4.9298	114	4
B		A				
B		A	C	4.8182	110	11
B		A	C			
B		A	C	4.7903	124	10
B		A	C			
B		A	C	4.7315	108	16
B		A	C			
B	D	A	C	4.6812	138	8
B	D	A	C			
B	D	A	C	4.5865	104	7
B	D	A	C			
B	D	A	C	4.5510	49	15
B	D		C			
B	D	E	C	4.5149	101	12
	D	E	C			
	D	E	C	4.4412	68	18
	D	E	C			
	D	E	C	4.3810	63	9
	D	E				
F	D	E		4.2535	71	1
F	D	E				
F	D	E		4.2449	49	14
F		E				
F		E		4.0678	59	2
F						
F				3.9259	27	5
F						
F				3.9000	30	3
F						
F				3.8182	33	6

Figure 4-25. Duncan's Multiple Range Test: Effectiveness (From the Overall Perspective)

```
        Alpha= 0.05  df= 1454  MSE= 1.526915
Means with the same letter are not significantly different.
```

Duncan Grouping									Mean	N	# of Tool/ joint practice
					A				4.9912	114	4
					A						
	B				A				4.9322	118	13
	B				A						
	B				A		C		4.8962	106	17
	B				A		C				
	B		D		A		C		4.7963	108	16
	B		D		A		C				
E	B		D		A		C		4.6855	124	10
E	B		D		A		C				
E	B		D		A		C		4.6667	138	8
E	B		D		A		C				
E	B		D		A		C		4.6545	110	11
E	B		D				C				
E	B		D			F	C		4.4554	101	12
E			D			F	C				
E		G	D			F	C		4.4231	104	7
E		G	D			F					
E		G	D			F			4.3673	49	15
E		G				F					
E		G				F		H	4.2857	63	9
E		G				F		H			
E		G				F		H	4.2647	68	18
		G				F		H			
		G		I		F		H	4.1020	49	14
		G		I		F		H			
		G		I		F		H	3.9661	59	2
		G		I				H			
		G		I				H	3.9333	30	3
				I				H			
				I				H	3.8148	27	5
				I							
				I					3.7042	71	1
				I							
				I					3.6970	33	6

Figure 4-26. Duncan's Multiple Range Test: Internalization (From the Overall Perspective)

Most effective ↑ ↓ Least effective	ISO 9000 and/or QS 9000 and/or Baldrige criteria (17)
	Quality audit (13), JIT delivery/production (4)
	Joint planning (11), Joint problem-solving team (10), Supplier or customer performance measurement system (16)
	Supplier certification or verification (8), Statistical process control (7), In-plant representative (15)
	Exchange of strategic information (12), Dynamic control tools (18), Joint quality education/training (9)
	Benchmarking (1), Joint investment on R & D (14), Cost of quality (2), Quality circles (5), Gainsharing (3), Quality function deployment (6)
Most internalized ↑ ↓ Least internalized	JIT delivery/production (4)
	Quality audit (13)
	ISO 9000 and/or QS 9000 and/or Baldrige criteria (17)
	Supplier or customer performance measurement system (16)
	Joint problem-solving team (10), Supplier certification or verification (8), Joint planning (11)
	Exchange of strategic information (12)
	Statistical process control (7), In-plant representative (15)
	Joint quality education/training (9), Dynamic control tools (18)
	Joint investment on R & D (14), Cost of quality (2), Gainsharing (3), Quality circles (5), Benchmarking (1), Quality function deployment (6)

Figure 4-27. Summary Results of Effectiveness and Internalization of Each Tool/Joint Practice (From the Overall Perspective)

Table 4-15. Means Values of Effectiveness and Internalization for Each Tool/Joint Practice (From Customer, Supplier, and Overall Perspective)

N: Frequency; Eff.: Effectiveness; Internal.: Internalization; M: Mean; SD: Standard Deviation

Tools/joint practices	Customer					Supplier					Overall				
	N	Eff.		Internal.		N	Eff.		Internal.		N	Eff.		Internal.	
		M	SD	M	SD		M	SD	M	SD		M	SD	M	SD
1	38	4.34	0.91	3.79	1.23	33	4.15	1.28	3.61	1.34	71	4.25	1.09	3.70	1.29
2	30	4.23	1.22	3.97	1.45	29	3.90	1.32	3.97	1.40	59	4.07	1.27	3.97	1.41
3	19	3.89	1.70	3.95	1.61	11	3.91	1.51	3.91	1.51	30	3.90	1.60	3.93	1.55
4	66	4.92	0.75	5.05	0.85	48	4.94	1.00	4.92	0.94	114	4.93	0.86	4.99	0.89
5	17	3.94	1.60	3.94	1.68	10	3.90	1.60	3.60	1.51	27	3.93	1.57	3.81	1.59
6	16	3.44	1.63	3.44	1.67	17	4.18	1.24	3.94	1.25	33	3.82	1.47	3.70	1.47
7	55	4.67	1.12	4.53	1.29	49	4.49	1.28	4.31	1.43	104	4.59	1.20	4.42	1.36
8	78	4.67	0.89	4.73	1.00	60	4.70	1.11	4.58	1.34	138	4.68	0.99	4.67	1.61
9	30	4.60	1.07	4.47	1.28	33	4.18	1.29	4.12	1.32	63	4.38	1.20	4.29	1.30
10	72	4.85	0.82	4.86	0.77	52	4.71	1.21	4.44	1.27	124	4.79	1.00	4.69	1.03
11	62	4.87	0.74	4.77	0.93	48	4.75	1.10	4.50	1.32	110	4.82	0.91	4.65	1.12
12	59	4.64	1.01	4.63	1.07	42	4.33	1.14	4.21	1.22	101	4.51	1.07	4.46	1.14
13	70	4.94	0.74	5.03	0.92	48	4.94	0.84	4.79	0.90	118	4.94	0.78	4.93	0.91
14	26	4.46	1.61	4.42	1.63	23	4.00	1.60	3.74	1.51	49	4.24	1.60	4.10	1.60
15	31	4.68	1.56	4.45	1.52	18	4.33	1.53	4.20	1.86	49	4.55	1.54	4.37	1.64
16	63	4.81	1.08	4.81	1.20	45	4.62	1.15	4.78	1.18	108	4.73	1.11	4.80	1.19
17	59	5.08	1.09	5.05	1.21	47	4.91	1.27	4.70	1.35	106	5.01	1.17	4.90	1.28
18	72	4.59	1.29	4.16	1.57	36	4.31	1.39	4.36	1.38	108	4.44	1.34	4.26	1.46

1: Benchmarking
4: JIT delivery/production
7: Statistical process control
10: Joint problem-solving teams
13: Quality audit
15: In-plant representative
17: ISO 9000 and/or QS 9000 and/or Baldrige criteria
18: Dynamic control tools (e.g., flow diagram, FMEA)

2: Cost of quality
5: Quality circles
8: Supplier certification/verification
11: Joint planning
14: Joint investment on R&D
16: Supplier or customer performance measurement system

3: Gainsharing
6: Quality Function Deployment
9: Joint quality education/training
12: Exchange of strategic information

Findings from Table 4-15 are:

- In general, the level of effectiveness was higher than the level of internalization regardless of perspectives, with some exceptions (tools/joint practices #3, 4, 8, and 13 from the customer perspective; #2, 16, and 18 from the supplier perspective; and #3,4, and 16 from the overall perspective).

- In general, the customers' level of effectiveness of tools/joint practices was higher than the suppliers' level of effectiveness of tools/joint practices, with some exceptions (tools/joint practices #3, 4, 6, and 8). This is shown graphically in Figure 4-28.

- In general, the customers' level of internalization of tools/joint practices was higher than the suppliers' level of internalization of tools/joint practices, with some exceptions (tools/joint practices #6 and 18). This is also graphically shown in Figure 4-29.
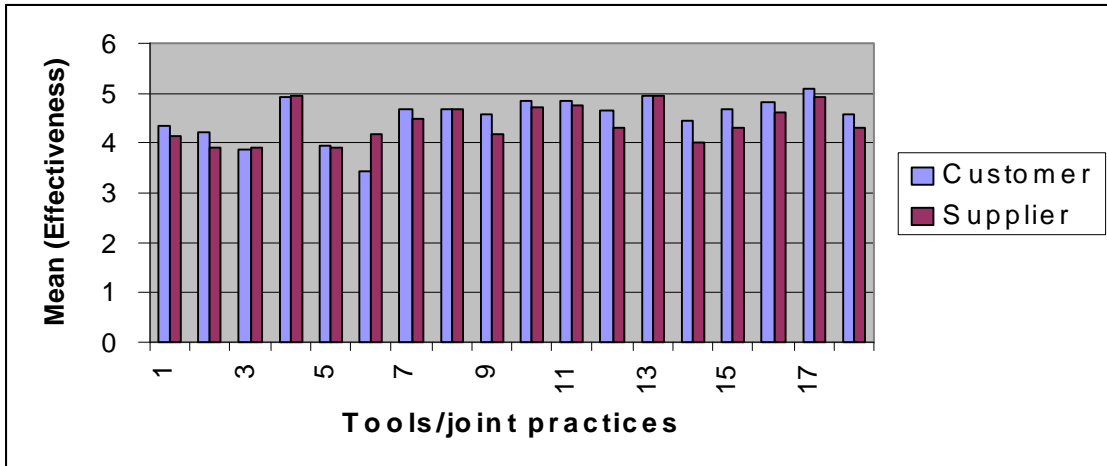
1: Benchmarking   2: Cost of quality   3: Gainsharing
4: JIT delivery/production   5: Quality circles   6: Quality Function Deployment
7: Statistical process control   8: Supplier certification/verification   9: Joint quality education/training
10: Joint problem-solving teams   11: Joint planning   12: Exchange of strategic information
13: Quality audit   14: Joint investment on R&D
15: In-plant representative   16: Supplier or customer performance measurement system
17: ISO 9000 and/or QS 9000 and/or Baldrige criteria
18: Dynamic control tools (e.g., flow diagram, FMEA)

Figure 4-28. Customers' Vs. Suppliers' Level of Effectiveness
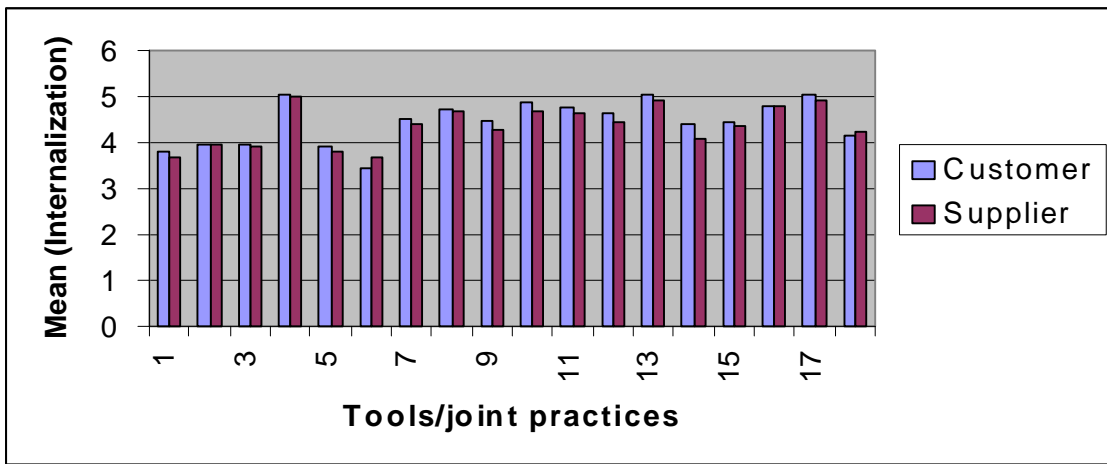
1: Benchmarking   2: Cost of quality   3: Gainsharing
4: JIT delivery/production   5: Quality circles   6: Quality Function Deployment
7: Statistical process control   8: Supplier certification/verification   9: Joint quality education/training
10: Joint problem-solving teams   11: Joint planning   12: Exchange of strategic information
13: Quality audit   14: Joint investment on R&D
15: In-plant representative   16: Supplier or customer performance measurement system
17: ISO 9000 and/or QS 9000 and/or Baldrige criteria
18: Dynamic control tools (e.g., flow diagram, FMEA)

Figure 4-29. Customers' Vs. Suppliers' Level of Internalization

CUSTOMER PERSPECTIVE	
Most effective ↑ ↓ Least effective	[1st] ISO 9000 and/or QS 9000 and/or Baldrige criteria (17) [2nd] Quality audit (13), JIT delivery/production (4), Joint planning (11), Joint problem-solving teams (10) [3rd] Supplier or customer performance measurement systems (16), In-plant representative (15), Statistical Process Control (7), Supplier certification or verification (8), Exchange of strategic information (12), Joint quality education/training (9), Dynamic control tools (18) [4th] Joint investment on R & D (14) [5th] Benchmarking (1), Cost of quality (2) [6th] Quality circles (5), Gainsharing (3), Quality function deployment (6)
Most internalized ↑ ↓ Least internalized	[1st] ISO 9000 and/or QS 9000 and/or Baldrige criteria (17), JIT delivery/production (4), Quality audit (13), Joint problem-solving teams (10), Supplier or customer performance measurement systems (16) [2nd] Joint planning (11), Supplier certification or verification (8), Exchange of strategic information (12) [3rd] Statistical Process Control (7), Joint quality education/training (9), In-plant representative (15), Joint investment on R & D (14) [4th] Dynamic control tools (18), [5th] Cost of quality (2), Gainsharing (3), Quality circles (5), Benchmarking (1), Quality function deployment (6)
SUPPLIER PERSPECTIVE	
Most effective ↑ ↓ Least effective	[1st] Quality audit (13), JIT delivery/production (4), ISO 9000 and/or QS 9000 and/or Baldrige criteria (17) [2nd] Joint planning (11), Joint problem-solving team (10), Supplier certification or verification (8) [3rd] Supplier or customer performance measurement system (16), Statistical process control (7), In-plant representative (15), Exchange of strategic information (12), Dynamic control tools (18), Joint quality education/training (9), Quality function deployment (6), Benchmarking (1), Joint investment on R & D (14), Gainsharing (3), Quality circles (5), Cost of quality (2)
Most internalized ↑ ↓ Least internalized	[1st] JIT delivery/production (4) [2nd] Quality audit (13), Supplier or customer performance measurement system (16) [3rd] ISO 9000 and/or QS 9000 and/or Baldrige criteria (17), Supplier certification or verification (8) [4th] Joint planning (11), Joint problem-solving team (10) [5th] Dynamic control tools (18), Statistical process control (7), In-plant representative (15), Exchange of strategic information (12), Joint quality education/training (9), Cost of quality (2), Quality function deployment (6), Gainsharing (3), Joint investment on R & D (14), Benchmarking (1), Quality circles (5)
OVERALL PERSPECTIVE	
Most effective ↑ ↓ Least effective	[1st] ISO 9000 and/or QS 9000 and/or Baldrige criteria (17) [2nd] Quality audit (13), JIT delivery/production (4) [3rd] Joint planning (11), Joint problem-solving team (10), Supplier or customer performance measurement system (16) [4th] Supplier certification or verification (8), Statistical process control (7), In-plant representative (15) [5th] Exchange of strategic information (12), Dynamic control tools (18), Joint quality education/training (9) [6th] Benchmarking (1), Joint investment on R & D (14), Cost of quality (2), Quality circles (5), Gainsharing (3), Quality function deployment (6)
Most internalized ↑ ↓ Least internalized	[1st] JIT delivery/production (4) [2nd] Quality audit (13) [3rd] ISO 9000 and/or QS 9000 and/or Baldrige criteria (17) [4th] Supplier or customer performance measurement system (16) [5th] Joint problem-solving team (10), Supplier certification or verification (8), Joint planning (11) [6th] Exchange of strategic information (12) [7th] Statistical process control (7), In-plant representative (15) [8th] Joint quality education/training (9), Dynamic control tools (18) [9th] Joint investment on R & D (14), Cost of quality (2), Gainsharing (3), Quality circles (5), Benchmarking (1), Quality function deployment (6)

Figure 4-30. Summary Results of Effectiveness and Internalization of Each Tool/Joint Practice (Combined)

Findings from Figure 4-30 are:

- Five tools/joint practices that have been used the most effectively regardless of perspectives are ISO 9000 and/or QS 9000 and/or Baldrige criteria, quality audit, JIT delivery/production, joint planning, and joint problem-solving teams. (These five tools/joint practices are shown in the first and second Duncan groups from both the customer and the supplier perspectives.)

- Five tools/joint practices that have been used the least effectively regardless of perspectives are benchmarking, cost of quality, quality circles, gainsharing, and quality function deployment. (These five tools/joint practices are shown in the last Duncan group from both the customer and the supplier perspectives.)

- Five tools/joint practices that have been the most internalized regardless of perspectives are ISO 9000 and/or QS 9000 and/or Baldrige criteria, quality audit, JIT delivery/production, joint problem-solving teams, and supplier or customer performance measurement system. (These five tools/joint practices are shown in the first Duncan group from the customer perspective and the first, second, and third Duncan groups from the supplier perspective.)

- Five tools/joint practices that have been the least internalized regardless of perspectives are cost of quality, gainsharing, quality circles, benchmarking, and quality function deployment. (These tools/joint practices are shown in the last Duncan group from both the customer and the supplier perspectives.)

From the above points, the following additional points can be made:

- Tools/joint practices that have been used the most effectively (4 out of 5: ISO 9000 and/or QS 9000 and/or Baldrige criteria, quality audit, JIT delivery/production, joint problem-solving teams) are also the most internalized (or institutionalized into the way customer and supplier organizations do business with their partners).

- All six tools/joint practices that have been used the least effectively (Joint investment on R & D, Cost of quality, Gainsharing, Quality circles, Benchmarking, Quality function deployment) also are the least internalized (or institutionalized into the way q1 and q3 organizations do business with their partners).

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4.3.5 Comparison of results of effectiveness and internalization of tools/joint practices used

The purpose of this section is to compare results derived from the answers to the first and second research questions. (Research question #1: *What joint tools and practices have been used by U.S. private manufacturing companies in q1-q3 joint action?*; Research question #2: *Which tools and joint practices have been more effective and internalized in q1-q3 joint action?*) To do this, key results of the two research questions are summarized in Figure 4-31.

Three tools/joint practices were identified that have been the most frequently used, used the most effectively, and have been the most internalized: JIT delivery/production, joint problem-solving teams, and quality audit. Three other tools and joint practices were also identified that have been the least frequently used, used the least effectively, and have been the least internalized: gainsharing, quality circles, and quality function deployment. However, no tool/joint practice was found that has been the most frequently used, but used the least effectively or the least internalized, and that has been the least frequently used, but used the most effectively and the most internalized.

Four most frequently used tools/joint practices	*Four least frequently used tools/joint practices*
JIT delivery/production	Gainsharing
Supplier certification or verification	Quality circles
Joint problem-solving team	Quality function deployment
Quality audit	Joint investment on R & D
Five tools/joint practices used the most effectively	*Five tools/joint practices used the least effectively*
JIT delivery/production	Benchmarking
Joint problem-solving teams	Cost of quality
Joint planning	Gainsharing
Quality audit	Quality circles
ISO 9000 and/or QS 9000 and/or Baldrige criteria	Quality function deployment
Five most internalized tools/joint practices	*Five least internalized tools/joint practices*
JIT delivery/production	Benchmarking
Joint problem-solving teams	Cost of quality
Quality audit	Gainsharing
Supplier or customer performance measurement system	Quality circles
ISO 9000 and/or QS 9000 and/or Baldrige criteria	Quality function deployment

**Figure 4-31. Frequency Vs. Levels of Effectiveness and Internalization
(From Table 4-9 and Figure 4-30)**

4.4 Results for Research Question #3[4]

To answer the third research question: ***What is the relationship between tools and joint practices and the shared results perceived by the customer and supplier?,*** the hypotheses in Figure 3-4 were tested using the following steps:

- First, a two-way ANOVA was used to determine if there was interaction between joint use of specific tools, TQMT, and joint practices, PRAC, in examining their combined relationship with each of the dependent variables − informed partners (INFPRT), role integrity (RI), conflict resolution (CR), and mutuality (MU).

- Second, if any significant interaction was detected at alpha level of 0.1, the results from the two-way ANOVA were used to explain the relationship between independent (combined TQMT and PRAC) and the four dependent variables. If, however, there was no interaction between TQMT and PRAC in examining their combined relationship with each of the four dependent variables, a one-way ANOVA was used to examine the relationship between each of the two independent and four dependent variables.

4.4.1 Results derived from the customer perspective

First, a two-way ANOVA was used to determine whether there was any significant interaction between the two independent variables in examining their relationship with four dependent variables. Tables 4-16 through 4-19 show the results.

In Table 4-16, for example, 94 responses completed from the customer perspective were used to calculate mean values of INFPRT; i.e., the average of perceived level of INFPRT. For example, when TQMT and PRAC, which are class variables in this research, were 2 and 3 respectively, the mean value of INFPRT was 3.78. Blank cells indicate that none of the 94 responses' levels of TQMT and PRAC fell into those cells.

To calculate average values of each of the four dependent variables with respect to the two independent variables' 6 point Likert-type scales, SAS "MEAN" function was

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[4] The independent variables used in this section are the set of items for TQMT (TQMT1, TQMT2, TQMT3, PRAC1, and PRAC3) and PRAC (PRAC2, PRAC5, PRAC6, and PRAC7), not individual tools/joint practices checked and listed in survey items # 45-46.

used. These mean values are shown in the last row and column of Tables 4-16, 4-17, and 4-19.

Table 4-16. Mean Values of INFPRT (From Two-Way ANOVA: Customer)

TQMT PRAC	1	2	3	4	5	6	Average
1	--	--	--	--	--	--	--
2	--	2.44	--	--	--	--	2.44
3	--	3.47	3.59	3.19	--	--	3.44
4	--	--	3.74	4.20	4.22	5.22	4.19
5	--	--	4.51	4.57	5.06	5.07	4.84
6	--	--	5.00	5.11	5.17	5.94	5.32
Average	--	3.11	4.24	4.43	4.96	5.53	--

TQMT	df: 4	mean square: 1.001	F value: 6.75	$p < 0.0001$
PRAC	df: 4	mean square: 2.938	F value: 19.65	$p < 0.0001$
TQMT*PRAC	df: 7	mean square: 0.273	F value: 1.83	$p < 0.0937$

Table 4-17. Mean Values of RI (From Two-Way ANOVA: Customer)

TQMT PRAC	1	2	3	4	5	6 -- --	Average
1	--	--	--	--	--	--	--
2	--	2.60	--	--	--	--	2.60
3	--	5.60	3.40	3.13	--	--	3.60
4	--	--	4.00	3.76	4.20	3.00	3.93
5	--	--	4.31	4.19	4.81	4.53	4.54
6	--	--	4.00	4.45	5.06	5.65	4.93
Average	--	4.10	4.03	4.04	4.76	4.90	--

TQMT	df: 4	mean square: 2.249	F value: 7.16	$p < 0.0001$
PRAC	df: 4	mean square: 3.533	F value: 11.24	$p < 0.0001$
TQMT*PRAC	df: 7	mean square: 0.573	F value: 1.82	$p < 0.0945$

Table 4-18. Mean Values of CR (From Two-Way ANOVA: Customer)

TQMT PRAC	1	2	3	4	5	6
1	--	--	--	--	--	--
2	--	2.71	--	--	--	--
3	--	2.71	3.38	3.76	--	--
4	--	--	3.90	3.94	3.86	3.71
5	--	--	4.53	4.61	4.80	4.67
6	--	--	5.00	5.25	5.47	5.68

TQMT	df: 4	mean square: 0.292	F value: 1.47	$p < 0.2192$
PRAC	df: 4	mean square: 4.102	F value: 20.69	$p < 0.0001$
TQMT*PRAC	df: 7	mean square: 0.109	F value: 0.55	$p < 0.7930$

Table 4-19. Mean Values of MU (From Two-Way ANOVA: Customer)

TQMT PRAC	1	2	3	4	5	6 -- --	Average
1	--	--	--	--	--	--	--
2	--	2.75	--	--	--	--	2.75
3	--	3.00	3.58	3.33	--	--	3.39
4	--	--	3.08	3.65	3.63	4.75	3.60
5	--	--	4.04	3.80	3.96	4.00	3.92
6	--	--	3.88	4.81	4.64	4.56	4.57
Average	--	2.88	3.73	3.87	4.02	4.38	--

TQMT	df: 4	mean square: 0.503	F value: 3.24	$p < 0.0164$
PRAC	df: 4	mean square: 1.011	F value: 6.51	$p < 0.0001$
TQMT*PRAC	df: 7	mean square: 0.465	F value: 2.99	$p < 0.0078$

As shown in Tables 4-16, 4-17, and 4-19, there were combined TQMT and PRAC effects on the levels of INFPRT, RI, and MU in examining their relationships. To test each hypothesis, the Student-Newman-Keuls multiple range test (SAS User's Guide, 5th Ed.) was conducted (SAS "SNK[5]" and "ALPHA=0.05" options of MEAN function) at a significance level of 0.05 in order to determine whether or not there was a significant difference between mean values.

Using the results from SAS "MEAN" function and "SNK" and "ALPHA=0.05" options, 8 hypotheses in Figure 3-4, as summarized below, were tested.

- ❑ **H1: Organizations with higher levels of TQMT have higher degrees of INFPRT.**
- ❑ **H2: Organizations with higher levels of TQMT have higher degrees of RI.**
- ❑ **H3: Organizations with higher levels of TQMT resolve conflicts less formally.**
- ❑ **H4: Organizations with higher levels of TQMT have higher degrees of MU.**
- ❑ **H5: Organizations with higher levels of PRAC have higher degrees of INFPRT.**
- ❑ **H6: Organizations with higher levels of PRAC have higher degrees of RI.**
- ❑ **H7: Organizations with higher levels of PRAC resolve conflicts less formally.**
- ❑ **H8: Organizations with higher levels of PRAC have higher degrees of MU.**

When an interaction was detected between TQMT and PRAC at α level of 0.1, the following four decision criteria[6](which are reproduced from Section 3.6.3.2) were used to accept or reject combined relationships between TQMT+PRAC and each of the four dependent variables. In other words, if all three decision criteria were met, the

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[5] SNK, which will be used hereafter, indicates Student-Newman-Keuls multiple range test or procedure.
[6] Decision criteria were provided by the Virginia Tech Statistical Consulting Center.

hypothesized relationship between combined TQMT+ PRAC and each of the four

dependent variables were supported. Otherwise, the hypotheses were not supported.

① μ (TQMT1) < μ (TQMT2) < μ (TQMT3) < μ (TQMT4) < μ (TQMT5) < μ (TQMT6);

② μ (PRAC1) < μ (PRAC2) < μ (PRAC3) < μ (PRAC4) < μ (PRAC5) < μ (PRAC6);

③ μ [Average of cell labeled (1)] < μ [Average of cells labeled (2)] < μ [Average of cells

labeled (3)] < μ [Average of cells labeled (4)] < ----- < μ [Average of cell labeled (11)];

④ No average values used in ①, ②, and ③ should be grouped in more than one SNK

grouping (see Figure 4-32).

Table 4-20. Mean Values of Dependent Variables (From Two-Way ANOVA)

TQMT PRAC	1	2	3	4	5	6	Average
1	(1)	(2)	(3)	(4)	(5)	(6)	μ (PRAC1)
2	(2)	(3)	(4)	(5)	(6)	(7)	μ (PRAC1)
3	(3)	(4)	(5)	(6)	(7)	(8)	μ (PRAC1)
4	(4)	(5)	(6)	(7)	(8)	(9)	μ (PRAC1)
5	(5)	(6)	(7)	(8)	(9)	(10)	μ (PRAC1)
6	(6)	(7)	(8)	(9)	(10)	(11)	μ (PRAC1)
Average	μ (TQMT1)	μ (TQMT2)	μ (TQMT3)	μ (TQMT4)	μ (TQMT5)	μ (TQMT6)	--

Ideally, if the hypotheses between combined TQMT+PRAC and each of the four

dependent variables were to be supported, mean values in all cells in Table 4-20 should

be arranged such that decision criteria ①, ②, and ③ are met. In addition, for differences

between values in the last row and column in Table 4-20 to be significant, no values in

the last row and column and average values of cell(s) labeled (1), (2), ---, (11) should be

grouped in more than one SNK grouping (decision criterion ④).

Figures 4-32 through 4-34 show the results from SNK multiple range tests with

respect to the relationships between TQMT+PRAC and each of INFPRT, RI, and MU

(variables for which there was interaction between TQMT and PRAC).

```
                 Number of observations in data set = 94

                          Anova Procedure
            Student-Newman-Keuls test for variable: INFPRT
                  Alpha= 0.05  df= 78  MSE= 0.149511

Number of Means          2         3         4         5
Critical Range  0.4221309 0.5066116 0.5566561 0.5921343

         SNK Grouping          Mean     N  TQMT
                      A        5.5278    8  6
                      B        4.9566   41  5
                      C        4.4325   28  4
                      C
                      C        4.2370   15  3
                      D        3.1111    2  2




Number of Means          2         3         4         5
Critical Range  0.5522948  0.662825 0.7283008 0.7747187

         SNK Grouping          Mean     N  PRAC
                      A        5.3203   17  6
                      B        4.8436   54  5
                      C        4.1852   15  4
                      D        3.4444    7  3
                      E        2.4444    1  2




         SNK Grouping          Mean     N  Cell(s)
                      A        5.9400    4  11
                      B        5.1400   10  10
                      B
                      C        5.0709   33  9
                      D        4.5183   24  8
                      D
                      D        4.3808   12  7
                      E        3.7800    6  6
                      E        3.5900    3  5
                      F        3.4650    1  4
                      G        2.4400    1  3
```

**Figure 4-32. SNK Multiple Range Test: Between TQMT+PRAC and INFPRT
(Two-Way ANOVA: Customer)**

```
                    Number of observations in data set = 94

                           Anova Procedure
               Student-Newman-Keuls test for variable: RI
                   Alpha= 0.05  df= 78  MSE= 0.314194

Number of Means            2         3          4          5
Critical Range  0.6119411 0.7344083 0.8069553 0.8583862

        SNK Grouping              Mean      N   TQMT
                     A          4.9000      8   6
                     A
                     A          4.7610     41   5
                     B          4.1000      2   2
                     B
                     B          4.0357     28   4
                     B
                     B          4.0267     15   3




Number of Means            2         3          4          5
Critical Range  0.8006328 0.9608628 1.0557796 1.1230692

        SNK Grouping              Mean      N   PRAC
                     A          4.9294     17   6
                     A
             B       A          4.5444     54   5
             B
             B       C          3.9333     15   4
                     C
                     C          3.6000      7   3
                     D          2.6000      1   2




        SNK Grouping              Mean      N   Cell(s)
                     A          5.6500      4   11
                     A          5.6000     10   4
                     B          4.9010     33   10
             C       B          4.7115     24   9
             C
             C                  4.1767     12   8
             C                  4.0808      6   7
                     D          3.5650      3   6
                     D          3.4000      1   5
                     E          2.6000      1   3
```

**Figure 4-33. SNK Multiple Range Test: Between TQMT+PRAC and RI
(Two-Way ANOVA: Customer)**

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```
                Number of observations in data set = 94


                         Anova Procedure
              Student-Newman-Keuls test for variable: MU
               Alpha= 0.05   df= 78   MSE= 0.155301


Number of Means          2         3         4          5
Critical Range  0.4302277 0.5163288 0.5673332  0.603492


          SNK Grouping            Mean      N   TQMT
                      A          4.3750     8   6
                      A
              B       A          4.0244    41   5
              B
              B                  3.8661    28   4
              B
              B                  3.7333    15   3
                      C          2.8750     2   2

Number of Means          2         3         4          5
 Critical Range  0.5628882 0.6755386 0.7422702 0.7895785


          SNK Grouping            Mean      N   PRAC
                      A          4.5735    17   6
                      B          3.9213    54   5
                      B
                      B          3.6000    15   4
                      B
                      B          3.3929     7   3
                      C          2.7500     1   2


          SNK Grouping            Mean      N   Cell(s)
                      A          4.5600     4   11
                      A
              B       A          4.4480    10   10
              B                  4.0870    33   9
              B
              B                  3.8775    24   7
              B
              B       C          3.7642    12   8
                      C
                      C          3.5800     6   5
                      D          3.2050     3   6
                      D          3.0000     1   4
                      E          2.7500     1   3
```

Figure 4-34. SNK Multiple Range Test: Between TQMT+PRAC and MU (Two-Way ANOVA: Customer)

Based on the results in Figures 4-32 through 4-34 and decision criteria described, the following decisions can be made.

Table 4-21. Hypothesis Testing (Two-Way ANOVA: Customer)

Hypotheses	Decision criteria 1	Decision criteria 2	Decision criteria 3	Decision criteria 4	Decision
H1 & H5	yes	yes	yes	yes	**Supported** [Organizations with higher levels of joint action (combined TQMT and PRAC) have higher degrees of informed partners (INFPRT).]
H2 & H6	no	yes	no	no	**Not supported** [Organizations with higher levels of joint action (combined TQMT and PRAC) have higher degrees of role integrity (RI).]
H4 & H8	yes	yes	no	no	**Not supported** [Organizations with higher levels of joint action (combined TQMT and PRAC) have higher degrees of mutuality (MU).]

In addition, to examine which one of the two independent variables had a main effect on the changes in dependent variables when there was an interaction between the two independent variables, the following analysis was done. Mean values of INFPRT with respect to TQMT and PRAC in Table 4-16 were plotted as shown in Figure 4-35. In Figure 4-35, distinguishable main effects were observed only in the lower levels of independent variables, 2 and 3. In this range, TQMT has a more positive effect on the degrees of INFPRT than does PRAC.
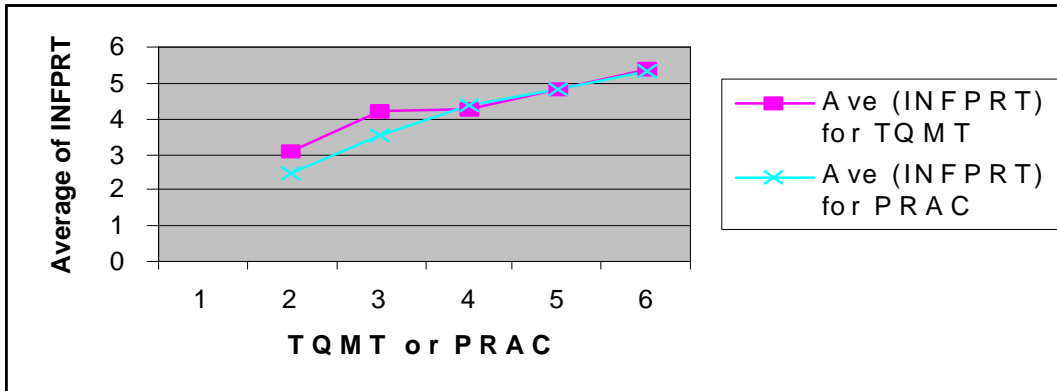
Figure 4-35. Changes in Average Values of INFPRT (Two-Way ANOVA: Customer)

Results in Table 4-18 indicate no significant combined TQMT and PRAC effect on the level of CR. Therefore, one-way ANOVA was used to examine the relationship between each of the two independent variables and CR using SAS "MEAN" function and "SNK" and "ALPHA=0.05" options. Table 4-22 shows the results.

Table 4-22. Mean Values of CR (From One-Way ANOVA: Customer)

TQMT	1	2	3	4	5	6
μ_{CR}	--	2.71	4.24	4.49	4.78	5.05
TQMT	df: 4	mean square: 3.082		F value: 7.29		p < 0.0001
PRAC	1	2	3	4	5	6
μ_{CR}	--	2.71	3.45	3.89	4.70	5.41
PRAC	df: 4	mean square: 8.054		F value: 40.39		p < 0.0001

When there was no interaction between TQMT and PRAC, similar decision criteria, provided by the Virginia Tech Statistical Consulting Center, were used as follows:

① μ (TQMT1) < μ (TQMT2) < μ (TQMT3) < μ (TQMT4) < μ (TQMT5) < μ (TQMT6);

or μ (PRAC1) < μ (PRAC2) < μ (PRAC3) < μ (PRAC4) < μ (PRAC5) < μ (PRAC6);

② No average values used in ① should be grouped in more than one SNK grouping.

In other words, if the above two decision criteria were met, the hypothesized relationship between each of the two independent variables and each of the four dependent variables were supported. Otherwise, the hypotheses were not supported.

The results shown in Table 4-22 and Figure 4-36 indicate that the remaining two hypotheses in Figure 3-4 were supported with a statistically significant level of 0.0001, as shown in Table 4-23.

```
                    Number of observations in data set = 94

                              Anova Procedure
                    Student-Newman-Keuls test for variable: CR

                       Alpha= 0.05   df= 89   MSE= 0.422876

    Number of Means           2         3         4         5
    Critical Range   0.7085539 0.8499768 0.9336619 0.9929249

            SNK Grouping              Mean      N   TQMT

                      A              5.0536      8   6
                      A
                      A              4.7770     41   5
                      A
                      A              4.4898     28   4
                      A
                      A              4.2381     15   3
                      B              2.7143      2   2


                       Alpha= 0.05   df= 89   MSE= 0.199394

    Number of Means           2         3         4         5
    Critical Range   0.6365705  0.763626 0.8388093 0.8920517

            SNK Grouping              Mean      N   PRAC

                      A              5.4118     17   6
                      B              4.7011     54   5
                      C              3.8857     15   4
                      C
                      C              3.4490      7   3
                      D              2.7143      1   2
```

Figure 4-36. SNK Multiple Range Test: TQMT-CR & PRAC-CR
(One-Way ANOVA: Customer)

Table 4-23. Hypothesis Testing (One-Way ANOVA: Customer)

Hypotheses	Decision criteria 1	Decision criteria 2	Decision
H3	yes	yes	**Supported** [Organizations with higher levels of joint use of specific tools (TQMT) resolve conflict less formally.]
H7	yes	yes	**Supported** [Organizations with higher levels of joint practices (PRAC) resolve conflict less formally.]

4.4.2   Results derived from the supplier perspective

The same steps and procedures were used to test hypotheses from the supplier perspective. Tables 4-24 through 4-27 show the mean values of dependent variables resulting from the two-way ANOVA.

Table 4-24. Mean Values of INFPRT (From Two-Way ANOVA: Supplier)

TQMT / PRAC	1	2	3	4	5	6
1	--	--	--	--	--	--
2	--	--	--	--	--	--
3	--	3.44	3.00	3.78	--	--
4	--	--	3.78	4.00	4.29	5.00
5	--	--	3.67	4.58	4.94	5.19
6	--	--	4.56	4.94	5.16	5.00

TQMT	df: 4	mean square: 0.734	F value: 5.22	$p < 0.0011$
PRAC	df: 3	mean square: 1.374	F value: 9.77	$p < 0.0001$
TQMT*PRAC	df: 7	mean square: 1.129	F value: 0.92	$p < 0.5000$

Table 4-25. Mean Values of RI (From Two-Way ANOVA: Supplier)

TQMT / PRAC	1	2	3	4	5	6
1	--	--	--	--	--	--
2	--	--	--	--	--	--
3	--	5.20	4.93	4.87	--	--
4	--	--	3.80	4.92	5.10	4.80
5	--	--	4.00	4.92	5.31	5.20
6	--	--	5.00	5.60	5.60	5.80

TQMT	df: 4	mean square: 0.767	F value: 3.41	$p < 0.0138$
PRAC	df: 3	mean square: 0.986	F value: 4.38	$p < 0.0073$
TQMT*PRAC	df: 7	mean square: 0.206	F value: 0.91	$p < 0.5021$

Table 4-26. Mean Values of CR (From Two-Way ANOVA: Supplier)

TQMT PRAC	1	2	3	4	5	6 -- --	Average
1	--	--	--	--	--	--	--
2	--	--	--	--	--	--	--
3	--	3.86	3.19	2.62	--	--	3.04
4	--	--	3.57	3.94	3.64	5.57	3.96
5	--	--	4.86	4.89	4.74	4.57	4.70
6	--	--	4.86	5.14	4.77	5.00	4.89
Average	--	3.86	3.81	4.19	4.41	4.98	--

TQMT	df: 4	mean square: 0.639	F value: 2.26	$p < 0.0722$
PRAC	df: 3	mean square: 3.891	F value: 13.79	$p < 0.0001$
TQMT*PRAC	df: 7	mean square: 0.734	F value: 2.60	$p < 0.0201$

Table 4-27. Mean Values of MU (From Two-Way ANOVA: Supplier)

TQMT PRAC	1	2	3	4	5	6
1	--	--	--	--	--	--
2	--	--	--	--	--	--
3	--	3.75	3.25	3.17	--	--
4	--	--	3.50	3.50	3.50	4.25
5	--	--	4.50	3.73	4.04	3.75
6	--	--	4.50	4.50	4.00	4.25

TQMT	df: 4	mean square: 0.174	F value: 1.05	$p < 0.3885$
PRAC	df: 3	mean square: 1.275	F value: 7.68	$p < 0.0002$
TQMT*PRAC	df: 7	mean square: 0.288	F value: 1.74	$p < 0.1169$

Except for one case (Table 4-26, CR), the results indicate that there was no significant combined TQMT and PRAC effect on the levels of INFPRT, RI, and MU. In the case of the relationship between joint action (combined TQMT and PRAC) and CR, the hypothesized relationship was not supported because decision criteria 1 and 3 were not met (see Figure 4-37), and the results are shown in Table 4-28.

Table 4-28. Hypothesis Testing (Two-Way ANOVA: Supplier)

Hypotheses	Decision criteria 1	Decision criteria 2	Decision criteria 3	Decision criteria 4	Decision
H3 & H7	no	yes	no	no	**Not supported** [Organizations with higher levels of joint action (combined TQMT and PRAC) resolve conflict less formally.]

```
                    Number of observations in data set = 78
                              Anova Procedure
                       Student-Newman-Keuls test for variable: CR
              Alpha= 0.05  df= 63  MSE= 0.282234

Number of Means              2         3          4          5
Critical Range  0.7937513  0.953394 1.0481719 1.1154554

        SNK Grouping              Mean       N  TQMT
                    A           4.9762      6   6
                    A
          B         A           4.4066     26   5
          B         A
          B         A           4.1868     39   4
          B
          B                     3.8571      1   2
          B
          B                     3.8095      6   3




        Number of Means             2         3          4
        Critical Range  0.4237048 0.5089222 0.5595147

        SNK Grouping              Mean       N  PRAC
                    A           4.8889      9   6
                    A
                    A           4.7009     32   5
          B                     3.9571     30   4
          C                     3.0408      7   3




        SNK Grouping              Mean       N  Cell(s)
                    A           5.0000      1  11
          B         A           4.8847      8   9
          B
          B                     4.6950     17  10
          B                     4.4721     24   8
                    C           3.9860     20   7
                    C
                    C           3.8600      4   4
                    D           3.1900      3   5
                    E           2.8575      1   6
```

Figure 4-37. SNK Multiple Range Test: Between TQMT+PRAC and CR (Two-Way ANOVA: Supplier)

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The remaining hypotheses that did not show a significant interaction between TQMT and PRAC were examined using one-way ANOVA. Tables 4-29 through 4-31 show the mean values of INFPRT, RI, and MU and p-values with respect to each of the two independent variables.

Table 4-29. Mean Values of INFPRT (From One-Way ANOVA: Supplier)

TQMT	1	2	3	4	5	6
μ_{INFPRT}	--	3.44	3.50	4.25	4.78	5.09
TQMT	df: 4	mean square: 3.308		F value: 13.22		p < 0.0001
PRAC	1	2	3	4	5	6
μ_{INFPRT}	--	--	3.40	4.14	4.75	5.02
PRAC	df: 3	mean square: 5.526		F value: 27.42		p < 0.0001

Table 4-30. Mean Values of RI (From One-Way ANOVA: Supplier)

TQMT	1	2	3	4	5	6
μ_{RI}	--	5.20	4.60	4.95	5.30	5.17
TQMT	df: 4	mean square: 0.834		F value: 3.38		p < 0.0136
PRAC	1	2	3	4	5	6
μ_{RI}	--	--	4.94	4.92	5.08	5.56
PRAC	df: 3	mean square: 0.967		F value: 3.88		p < 0.0125

Table 4-31. Mean Values of MU (From One-Way ANOVA: Supplier)

TQMT	1	2	3	4	5	6
μ_{MU}	--	3.75	3.71	3.82	3.86	4.00
TQMT	df: 4	mean square: 0.356		F value: 1.54		p < 0.0295
PRAC	1	2	3	4	5	6
μ_{MU}	--	--	3.29	3.55	3.88	4.19
PRAC	df: 3	mean square: 1.679		F value: 9.33		p < 0.0001

As shown in Tables 4-29 through 4-31 and Figures 4-38 through 4-40, four hypothesized relationships were not supported and two hypothesized relationships were supported. The results are summarized in Table 4-32.

```
                    Number of observations in data set = 78

                              Anova Procedure
                    Student-Newman-Keuls test for variable: INFPRT


                        Alpha= 0.05  df= 73  MSE= 0.250159

Number of Means           2          3          4          5
Critical Range  0.7452955 0.8946363 0.9831729 1.0459645


        SNK Grouping              Mean      N  TQMT


                    A             5.0926    6  6
                    A
                    A             4.7821   26  5
                    A
              B     A             4.2536   39  4
              B
              B             3.5000    6  3
              B
              B             3.4444    1  2



               Alpha= 0.05  df= 74  MSE= 0.201552

        Number of Means           2          3          4
        Critical Range  0.3570217 0.4285382 0.4709317


        SNK Grouping              Mean      N  PRAC


                    A             5.0247    9  6
                    A
                    A             4.7535   32  5
                    B             4.1370   30  4
                    C             3.3968    7  3
```

**Figure 4-38. SNK Multiple Range Test: TQMT-INFPRT & PRAC-INFPRT
(One-Way ANOVA: Supplier)**

```
               Number of observations in data set = 78

                        Anova Procedure
              Student-Newman-Keuls test for variable: RI

              Alpha= 0.05   df= 73   MSE= 0.246997

    Number of Means          2         3         4         5
    Critical Range  0.7405695 0.8889633 0.9769385 1.0393319

            SNK Grouping           Mean      N   TQMT

                        A        5.3000     26   5
                        A
                        A        5.2000      1   2
                        A
                        A        5.1667      6   6
                        A
                        A        4.9487     39   4
                        A
                        A        4.6000      6   3


                 Alpha= 0.05   df= 74   MSE= 0.249559

        Number of Means          2         3         4
        Critical Range  0.3972713 0.4768504 0.5240232

            SNK Grouping           Mean      N   PRAC

                        A        5.5556      9   6
                        B        5.0750     32   5
                        B
                        B        4.9429      7   3
                        B
                        B        4.9200     30   4
```

**Figure 4-39. SNK Multiple Range Test: TQMT-RI & PRAC-RI
(One-Way ANOVA: Supplier)**

```
                Number of observations in data set = 78

                         Anova Procedure
             Student-Newman-Keuls test for variable: MU


                 Alpha= 0.05  df= 73  MSE= 0.23201

Number of Means          2         3          4          5
Critical Range  0.7177498  0.861571 0.9468354 1.0073062


        SNK Grouping              Mean      N  TQMT


                     A          4.0000      6  6
                     A
                     A          3.8654     26  5
                     A          3.8154     39  4
                     A          3.7500      1  2
                     A
                     A          3.7083      6  3



                 Alpha= 0.05  df= 74  MSE= 0.180052

      Number of Means          2         3          4
      Critical Range  0.3374422 0.4050367 0.4451053


        SNK Grouping              Mean      N  PRAC


                     A          4.1944      9  6
                     A
              B      A          3.8828     32  5
              B
              B      C          3.5500     30  4
                     C
                     C          3.2857      7  3
```

Figure 4-40. SNK Multiple Range Test: TQMT-MU & PRAC-MU
(One-Way ANOVA: Supplier)

Table 4-32. Hypothesis Testing (One-Way ANOVA: Supplier)

Hypotheses	Decision criteria 1	Decision criteria 2	Decision
H1	yes	no	**Not supported** [Organizations with higher levels of joint use of specific tools (TQMT) have higher degrees of informed partners (INFPRT).]
H2	no	yes	**Not supported** [Organizations with higher levels of joint use of specific tools (TQMT) have higher degrees of role integrity (RI).]
H4	no	yes	**Not supported** [Organizations with higher levels of joint use of specific tools (TQMT) have higher degrees of mutuality (MU).]
H5	yes	yes	**Supported** [Organizations with higher levels of joint practices (PRAC) have higher degrees of informed partners (INFPRT).]
H6	no	yes	**Not supported** [Organizations with higher levels of joint practices (PRAC) have higher degrees of role integrity (RI).]
H8	yes	no	**Not supported** [Organizations with higher levels of joint practices (PRAC) have higher degrees of mutuality (MU).]

4.4.3 Results derived from the overall perspective

All 172 responses were used to test hypotheses from the overall perspective using the same steps and procedures as in Sections 4.4.1 and 4.4.2. First, a two-way ANOVA was used to determine if there was any interaction between TQMT and PRAC in examining their relationship with each dependent variable. Tables 4-33 through 4-36 show the results.

Table 4-33. Mean Values of INFPRT (From Two-Way ANOVA: Overall)

TQMT / PRAC	1	2	3	4	5	6
1	--	--	--	--	--	--
2	--	2.44	--	--	--	--
3	--	3.61	3.30	3.48	--	--
4	--	--	3.75	4.04	4.26	5.07
5	--	--	4.40	4.57	5.02	5.13
6	--	--	4.85	5.06	5.17	5.76

TQMT	df: 4	mean square: 1.996	F value: 13.26	p < 0.0001
PRAC	df: 4	mean square: 4.832	F value: 32.09	p < 0.0001
TQMT*PRAC	df: 7	mean square: 0.186	F value: 1.24	p < 0.2861

Table 4-34. Mean Values of RI (From Two-Way ANOVA: Overall)

TQMT / PRAC	1	2	3	4	5	6
1	--	--	--	--	--	--
2	--	2.60	--	--	--	--
3	--	5.40	4.17	4.00	--	--
4	--	--	3.95	4.68	4.71	4.20
5	--	--	4.28	4.54	4.97	4.87
6	--	--	4.33	4.83	5.28	5.68

TQMT	df: 4	mean square: 2.497	F value: 5.77	$p < 0.0002$
PRAC	df: 4	mean square: 2.635	F value: 6.09	$p < 0.0001$
TQMT*PRAC	df: 7	mean square: 0.619	F value: 1.43	$p < 0.1971$

Table 4-35. Mean Values of CR (From Two-Way ANOVA: Overall)

TQMT / PRAC	1	2	3	4	5	6	Average
1	--	--	--	--	--	--	--
2	--	2.71	--	--	--	--	2.71
3	--	3.29	3.29	3.19	--	--	3.24
4	--	--	3.82	3.94	3.73	4.95	3.93
5	--	--	4.57	4.65	4.78	4.62	4.70
6	--	--	4.95	5.21	5.18	5.54	5.23
Average	--	3.09	4.12	4.31	4.63	5.02	--

TQMT	df: 4	mean square: 0.688	F value: 2.65	$p < 0.0352$
PRAC	df: 4	mean square: 6.680	F value: 25.75	$p < 0.0001$
TQMT*PRAC	df: 7	mean square: 0.495	F value: 1.91	$p < 0.0717$

Table 4-36. Mean Values of MU (From Two-Way ANOVA: Overall)

TQMT / PRAC	1	2	3	4	5	6	Average
1	--	--	--	--	--	--	--
2	--	2.75	--	--	--	--	2.75
3	--	3.75	3.25	3.17	--	--	3.34
4	--	--	3.50	3.50	3.50	4.25	3.57
5	--	--	4.50	3.73	4.04	3.75	3.91
6	--	--	4.50	4.50	4.00	4.25	4.44
Average	--	3.17	3.73	3.72	3.96	4.21	--

TQMT	df: 4	mean square: 0.341	F value: 2.08	$p < 0.0860$
PRAC	df: 4	mean square: 2.133	F value: 13.02	$p < 0.0001$
TQMT*PRAC	df: 7	mean square: 0.567	F value: 3.46	$p < 0.0018$

The results indicate that there was no significant interaction between TQMT and PRAC in examining their relationship with INFPRT and RI. Therefore, these two hypothesized relationships were further analyzed using the one-way ANOVA as in Tables 4-38 and 4-39.

In the case of the relationships between the combined TQMT and PRAC and each of CR and MU, the results in Figures 4-41 and 4-42 indicate a lack of support for the two hypotheses (see Table 4-37 for summary).

```
                    Number of observations in data set = 172

                            Anova Procedure
                  Student-Newman-Keuls test for variable: CR
                      Alpha= 0.05  df= 156  MSE= 0.259391

Number of Means            2         3          4           5
Critical Range   0.4418407 0.5293127 0.5808967 0.6173566


        SNK Grouping              Mean      N  TQMT
                    A            5.0204    14  6
                    B            4.6333    67  5
                    B
        C           B            4.3134    67  4
        C
        C                        4.1156    21  3
                    D            3.0952     3  2




Number of Means            2         3          4           5
Critical Range   0.6804583 0.8151699  0.894612 0.9507622


        SNK Grouping              Mean      N  PRAC
                    A            5.2308    26  6
                    A
                    A            4.7010    86  5
                    B            3.9333    45  4
                    C            3.2449    14  3
                    C
                    C            2.7143     1  2




        SNK Grouping              Mean      N  Cell(s)
                    A            5.5400     5  11
                    B            4.9933    18  10
                    B
        C           B            4.8418    50  9
        C                        4.4004    48  8
        C
        C                        4.0975    32  7
                    D            3.4420    10  6
                    D            3.2900     6  5
                    D            3.2900     2  4
                    E            2.7100     1  3
```

Figure 4-41. SNK Multiple Range Test: Between TQMT+PRAC and CR (Two-Way ANOVA: Overall)

```
                    Number of observations in data set = 172

                            Anova Procedure
                  Student-Newman-Keuls test for variable: MU
                      Alpha= 0.05  df= 156  MSE= 0.163765

Number of Means           2         3          4          5
Critical Range   0.3510746 0.4205775 0.4615647 0.4905348

           SNK Grouping              Mean      N   TQMT
                        A            4.2143    14   6
                        A
             B          A            3.9627    67   5
             B
             B                       3.7262    21   3
             B
             B                       3.7201    67   4
                        C            3.1667     3   2




Number of Means           2         3          4          5
Critical Range   0.5406737 0.6477118 0.7108344 0.7554499

           SNK Grouping              Mean      N   PRAC
                        A            4.4423    26   6
                        B            3.9070    86   5
                        B
             C          B            3.5667    45   4
             C
             C                       3.3393    14   3
                        D            2.7500     1   2




           SNK Grouping              Mean      N   Cell(s)
                        A            4.2500     5   11
             B          A            4.1078    18   9
             B                       3.9167    50   10
                        C            3.7500    48   7
                        C
                        C            3.7500    32   4
                        C            3.7110    10   8
                        D            3.3020     6   6
                        D            3.2500     2   5
                        E            2.7500     1   3
```

**Figure 4-42. SNK Multiple Range Test: Between TQMT+PRAC and MU
(Two-Way ANOVA: Overall)**

Table 4-37. Hypothesis Testing (Two-Way ANOVA: Overall)

Hypotheses	Decision criteria 1	Decision criteria 2	Decision criteria 3	Decision criteria 4	Decision
H3 & H7	yes	yes	yes	no	**Not supported** [Organizations with higher levels of joint action (combined TQMT and PRAC) resolve conflict less formally.]
H4 & H8	no	yes	no	no	**Not supported** [Organizations with higher levels of joint action (combined TQMT and PRAC) have higher degrees of mutuality (MU).]

Next, the relationships between each TQMT and PRAC and INFPRT and RI were examined using one-way ANOVA. Tables 4-38 and 4-39 show the results.

Table 4-38. Mean Values of INFPRT (From One-Way ANOVA: Overall)

TQMT	1	2	3	4	5	6
μ_{INFPRT}	--	3.22	4.03	4.33	4.89	5.34
TQMT	df: 4	mean square: 7.676		F value: 25.19		$p < 0.0001$
PRAC	1	2	3	4	5	6
μ_{INFPRT}	--	2.44	3.42	4.15	4.81	5.22
PRAC	df: 4	mean square: 11.676		F value: 55.90		$p < 0.0001$

Table 4-39. Mean Values of RI (From One-Way ANOVA: Overall)

TQMT	1	2	3	4	5	6
μ_{RI}	--	4.47	4.19	4.57	4.97	5.01
TQMT	df: 4	mean square: 3.260		F value: 6.63		$p < 0.0001$
PRAC	1	2	3	4	5	6
μ_{RI}	--	2.60	4.27	4.59	4.74	5.15
PRAC	df: 4	mean square: 3.203		F value: 6.49		$p < 0.0001$

In addition, to examine if differences between mean values are significant, SNK multiple range test was conducted, and results are shown in Figures 4-43 and 4-44.

```
                    Number of observations in data set = 172

                             Anova Procedure
                 Student-Newman-Keuls test for variable: INFPRT

                    Alpha= 0.05  df= 167  MSE= 0.304695

    Number of Means           2         3         4         5
    Critical Range  0.4786269  0.573314 0.6291356 0.6685827

            SNK Grouping             Mean      N   TQMT

                        A          5.3413     14  6
                        A
                        A          4.8889     67  5
                        B          4.3284     67  4
                        B
                        B          4.0265     21  3
                        C          3.2222      3  2


                    Alpha= 0.05  df= 167  MSE= 0.208888

    Number of Means           2         3         4         5
    Critical Range  0.6103197 0.7310596 0.8022404 0.8525413

            SNK Grouping             Mean      N   PRAC

                        A          5.2179     26  6
                        A
                        A          4.8101     86  5
                        B          4.1531     45  4
                        C          3.4206     14  3
                        D          2.4444      1  2
```

Figure 4-43. SNK Multiple Range Test: TQMT-INFPRT & PRAC-INFPRT
(One-Way ANOVA: Overall)

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```
                    Number of observations in data set = 172

                            Anova Procedure
                    Student-Newman-Keuls test for variable: RI


                    Alpha= 0.05   df= 167   MSE= 0.492036

Number of Means          2          3          4          5
Critical Range   0.6082233 0.7285485 0.7994848 0.8496129

        SNK Grouping              Mean      N   TQMT

                    A          5.0143     14  6
                    A
                    A          4.9701     67  5
                    A
                    A          4.5672     67  4
                    A
                    A          4.4667      3  2
                    A
                    A          4.1905     21  3



                    Alpha= 0.05   df= 167   MSE= 0.493407

Number of Means          2          3          4          5
Critical Range   0.9380006 1.1235658 1.2329637 1.3102711

        SNK Grouping              Mean      N   PRAC

                    A          5.1462     26  6
                    A
                    A          4.7419     86  5
                    A
                    A          4.5911     45  4
                    A
                    A          4.2714     14  3
                    B          2.6000      1  2
```

Figure 4-44. SNK Multiple Range Test: TQMT-RI & PRAC-RI
(One-Way ANOVA: Overall)

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The results in Tables 4-38 and 4-39 and Figures 4-43 and 4-44 indicate all hypotheses were supported except for the relationship between TQMT and RI. These are summarized in Table 4-40.

Table 4-40. Hypothesis Testing (One-Way ANOVA: Overall)

Hypotheses	Decision criteria 1	Decision criteria 2	Decision
H1	yes	yes	**Supported** [Organizations with higher levels of joint use of specific tools (TQMT) have higher degrees of informed partners (INFPRT).]
H2	no	yes	**Not supported** [Organizations with higher levels of joint use of specific tools (TQMT) have higher degrees of role integrity (RI).]
H5	yes	yes	**Supported** [Organizations with higher levels of joint practices (PRAC) have higher degrees of informed partners (INFPRT).]
H6	yes	yes	**Supported** [Organizations with higher levels of joint practices (PRAC) have higher degrees of role integrity (RI).]

4.4.4   Overall results for research question #3

This section combines all the results in Sections 4.4.1 - 4.4.3 to derive additional findings from three perspectives, including differences and similarities in terms of (1) whether or not hypotheses were supported and (2) whether one-way or two way ANOVA was used. Table 4-41 shows summary results.

Table 4-41. Summary Results for Research Question #3 (Hypothesis Testing)

Perspec-tives	Hypothesized relationships							
	H1: TQMT-INFPRT	**H5**: PRAC-INFPRT	**H2**: TQMT-RI	**H6**: PRAC-RI	**H3**: TQMT-CR	**H7**: PRAC-CR	**H4**: TQMT-MU	**H8**: PRAC-MU
Customer	Supported (two-way)		Not supported (two-way)		Supported (one-way)	Supported (one-way)	Not supported (two-way)	
Supplier	Not supported (one-way)	Supported (one-way)	Not supported (one-way)	Not supported (one-way)	Not supported (two-way)		Not supported (one-way)	Not supported (one-way)
Overall	Supported (one-way)	Supported (one-way)	Not supported (one-way)	Supported (one-way)	Not supported (two-way)		Not supported (two-way)	

Findings from Table 4-41 include:

- The way customer and supplier organizations relate joint action to shared results was different. For example, customers perceived joint use of specific tools (TQMT) and other joint practices (PRAC) as a combined intervention in measuring three shared result dimensions: informed partners (INFPRT), role integrity (RI), and mutuality (MU). However, suppliers perceived joint use of specific tools (TQMT) and other joint practices (PRAC) separately in measuring the same three shared result dimensions (see the customer and the supplier perspectives rows of Table 4-34).

- On the other hand, customers differentiated joint use of specific tools (TQMT) from other joint practices (PRAC) in measuring conflict resolution (CR), while suppliers did not.

- In the case of the relationships between joint action and role integrity (RI: see H2 and H6) and between joint action and mutuality (MU: see H4 an H8), customers and suppliers in this sample seemed to share the same experience. Customers and suppliers did not perceive higher levels of joint action related to higher levels of role integrity (RI) or mutuality (MU).

- In the case of the relationship between joint action and conflict resolution (CR: see H3 and H7), customers' and suppliers' perceptions were not the same, such that results from the customer perspective supported both H3 and H7, while results from the supplier perspective did not support the combined hypothesis.

The results and findings presented in this section, including the 8 hypotheses tested, will be further discussed in the following chapter. This will be done by comparing the results from this research with those from previous relationalism studies to determine if there are any similarities or differences.

4.5 Results for Research Question #4

To answer the fourth research question: *What changes (increase or decrease) in organizational performance dimensions (quality, cost, and cycle time) are perceived as a result of q1-q3 joint action and shared results?*, responses to survey Items #47 and 48 were used. The following five points are addressed in this section:

- Average perceived changes (i.e., improvements) in three organizational performance dimensions (quality, cost, and cycle time) with respect to three perspectives (customer, supplier, and overall) measured as percentage of increase or decrease,

- Other organizational performance dimensions identified by managers other than quality, cost, and cycle time,

- Tools/joint practices used to improve/decrease three perceived organizational performance dimensions with respect to three perspectives,

- The overall effect on organizational performance resulting from using all tools/joint practices identified, and

- Differences between *perceived* improvements in organizational performance dimensions (this research) and organizational performance improvements *measured objectively* by other researchers.

    Table 4-42 shows the average perceived improvements in three organizational performance dimensions with respect to three perspectives.

Table 4-42. Average Perceived Improvements in Three Organizational Performance Dimensions

N: Number of response.

Perspectives	Customer			Supplier			Overall		
Performance Dimensions	N	Mean	Std Dev	N	Mean	Std Dev	N	Mean	Std Dev
Quality	67	31	43.21	54	28	23.58	121	30	35.71
Cost	59	24	27.99	48	18	18.60	107	21	24.29
Cycle time	50	28	25.08	42	23	20.63	92	26	23.19

    As shown, quality was the most improved performance dimension perceived by managers as a result of q1-q3 joint action, followed by cycle time and cost, regardless of perspectives. Although no evidence was provided from this research regarding why quality was the most improved performance dimension, one possible reason may be that a higher number of responses was recorded from managers of quality related functions than other positions. This is partially supported by the average perceived improvement in quality categorized by respondents' titles: 27% improvement in quality (21 managers of sales/marketing), 26% (30 managers of purchasing), 33% (46 managers of quality), 29%

(13 managers of operations/production), and 28% (11 managers of other functions). In other words, a higher perceived improvement in quality may be due to the nature of the job position of respondents, where quality managers would be expected to have increased attention to quality and be involved with initiatives specifically to improve quality.

Other than the three perceived organizational performance dimensions, 15 out of 121 respondents listed additional performance dimensions and their percentage changes (see Figure 4-45).

Other performance dimensions identified by customers (& percentage changes)

Technical growth	3% increase	Material availability	5% increase
On-time delivery	22% increase	On-time delivery (2)	20% increase
On-time delivery	50% increase	Cooperation	100% increase
Delivery	15% increase	Responsiveness	15% increase
Technological innovation	10% increase		
Cost of product (out the door)	22% decrease		
Supplier creative action report	100 % increase		

Other performance dimensions identified by suppliers (& percentage changes)

Delivery	20% increase	Customer inventory	N/A
Sales growth	20% increase	On-time delivery	22% increase
Amount of scrap	2% decrease	Inventory turns	50% increase
Customer satisfaction	15% increase	Management awareness	20% increase

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**Figure 4-45. Other Perceived Organizational Performance Dimensions
Identified by Respondents**

Next, tools/joint practices were examined to see which tools/joint practices were considered most responsible for perceived improvements in each of the three dimensions in terms of their frequency identified by respondents. Table 4-43 shows the results (the number in parentheses is the number of individuals, customers or suppliers, whose responses' for the survey Item #47 were used to count the frequency of tools/joint practices, which are shown in each cell, to improve each of the three organizational performance dimensions). For example, supplier certification/verification (tool/joint practice # 8) was identified 14 times by 67 customers and 12 times by 54 suppliers as a means to improve quality.

Findings from Table 4-43 are:

- Two tools/joint practices – QFD (tool/joint practice #6) and joint investment on R & D (tool/joint practice #14) – have been used exclusively by suppliers to improve quality.

- Quality circles (tool/joint practice #5) have been used exclusively by suppliers to reduce cost.

- QFD (tool/joint practice #6) has not been used by either customers or suppliers to reduce cycle time.

Table 4-43. Frequency of Tools/Joint Practices Used to Improve Quality, Cost, and Cycle Time

C: Customer   S: Supplier   O: Overall

Tools/joint practices	Quality			Cost			Cycle time		
	C (67)	S (54)	O (121)	C (59)	S (48)	O (107)	C (50)	S (42)	O (92)
1	8	6	14	8	3	11	5	6	11
2	2	6	8	7	9	16	0	1	1
3	1	1	2	7	4	11	1	0	1
4	6	4	10	21	11	32	27	17	44
5	1	4	5	0	2	2	0	1	1
6	0	10	10	2	2	4	0	0	0
7	21	21	42	6	12	18	3	6	7
8	14	12	26	4	8	12	4	3	9
9	7	6	13	5	2	7	1	3	4
10	28	14	42	15	13	28	10	6	16
11	4	8	12	14	13	27	18	14	32
12	9	6	15	19	9	28	12	6	18
13	25	15	40	7	9	16	2	3	5
14	0	5	5	3	5	8	1	4	5
15	6	6	12	4	3	7	6	1	7
16	21	12	33	8	6	14	5	1	6
17	13	15	28	6	5	11	7	0	7
18	10	8	18	4	4	8	2	1	3
Total [Average]	176 [2.63]	159 [2.94]	335 [2.77]	140 [2.37]	120 [2.50]	260 [2.43]	104 [2.08]	73 [1.74]	177 [1.92]

1: Benchmarking 2: Cost of quality 3: Gainsharing
4: JIT delivery/production 5: Quality circles 6: Quality Function Deployment
7: Statistical process control 8: Supplier certification/verification 9: Joint quality education/training
10: Joint problem-solving teams 11: Joint planning 12: Exchange of strategic information
13: Quality audit 14: Joint investment on R&D
15: In-plant representative 16: Supplier or customer performance measurement system
17: ISO 9000 and/or QS 9000 and/or Baldrige criteria
18: Dynamic control tools (e.g., flow diagram, FMEA)

- ISO 9000 and/or QS 9000 and/or Baldrige criteria (tool/joint practice #17) have been used exclusively by customers to reduce cycle time.
- Tools/joint practices used most *and* least to improve three perceived performance dimensions are also derived from Table 4-43. They are shown in Table 4-44. (Only two or three most *and* least used tools/joint practices were selected from Table 4-43. Tools/joint practices identified the same number of times were indicated by the symbol '&.')

Table 4-44. Tools/Joint Practices Used Most *and* Least (or Never Used)

C: Customer   S: Supplier   O: Overall

	Quality			Cost			Cycle time		
	C	S	O	C	S	O	C	S	O
Tools/joint practices used most	10 13 7 &16	7 13 & 17 10	7 10 13	4 12 10	10 7 4	4 10 12	4 11 12	4 11 1 & 10 & 12	4 11 12
Tools/joint practices used least (or never used)	6 7 3 & 5	3 4 & 5 14	3 5 & 14 8	5 6 14	5 & 6 & 15 1 & 15	5 6 9 & 15	2 & 5 & 6 3 & 9 & 14	3 & 6 & 17 2 & 5 & 15 & 16 & 18	6 2 & 3 & 5

1: Benchmarking
4: JIT delivery/production
7: Statistical process control
10: Joint problem-solving teams
13: Quality audit
15: In-plant representative
17: ISO 9000 and/or QS 9000 and/or Baldrige criteria
18: Dynamic control tools (e.g., flow diagram, FMEA)

2: Cost of quality
5: Quality circles
8: Supplier certification/verification
11: Joint planning
14: Joint investment on R&D
16: Supplier or customer performance measurement system

3: Gainsharing
6: Quality Function Deployment
9: Joint quality education/training
12: Exchange of strategic information

Respondents reported a 25% overall improvement in perceived organizational performance as a result of using all tools/joint practices identified (average 25% improvement from 68 customers and 25% improvement from 57 suppliers).

To identify differences, if any, between perceived and objectively measured organizational performance improvements in quality, cost, and cycle time, Table 2-8 in Chapter 2 and findings from this research were compared. Table 4-45 shows the results.

Table 4-45. Perceived Vs. Objective Performance Improvements in Quality, Cost and Cycle Time

Performance Dimensions	Perceived improvements (in this research)	Objective improvements (from Table 2-8)
Increase in quality	Customer: 31% Supplier: 28% Overall: 30%	Re-return rate: 14% Overall filed return rate: 17% No trouble found rate: 19% Reduction in scrap rate: 21% Reduction in q3's rework: 24% q1's quality improvement: 26%
Decrease in cost	Customer: 24% Supplier: 18% Overall: 21%	Cost reduction: 11% Reduction in drafting expense: 20% Reduction in WIP inventory: 31%
Decrease in cycle time	Customer: 28% Supplier: 23% Overall: 26%	Lead time reduction: 29%

Two noticeable findings were derived from Table 4-45. First, the overall improvement in quality that is perceived by participants in this research was higher than the improvement in quality that was objectively measured by other researchers. Second, compared to this research, a slightly higher improvement (reduction) in cycle time was observed in previous studies that objectively measured lead time. A conclusion regarding perceived vs. objective improvements in specific organizational performance dimensions will be addressed in Chapter 5.

4.6   *Supplementary Results*

This section presents results that are supplemental to the four research questions defined in Chapter 1. This was done by analyzing survey response data to examine (1) which variables are related to *satisfaction with partners* and *overall quality of partnership* and (2) which variables are related to *joint use of tools* (TQMT) and *joint practices* (PRAC). For the supplementary results described in the following two sections, a SAS regression function "REG" was used to produce results in Figures 4-46 through 4-49.

4.6.1   Satisfaction with partners and the overall quality of partnership

For a regression analysis, both satisfaction with partners (survey Item #49) and the overall quality of partnership (survey Item # 50) were treated as dependent variables.

Eight other variables − business experience with a particular partner (or duration of partnership [DURA]), the number of tools/joint practices used (identified by survey Items # 45 & 46; NoTOOL), TQMT, PRAC, INFPRT, RI, CR, and MU − were treated as independent variables. Figures 4-46 and 4-47 show the results.

As shown in Figure 4-46, from the customer perspective, two variables (TQMT and MU) had a significant positive effect on satisfaction with partner (although MU is borderline), and one variable (RI) had a significant (borderline) negative effect on satisfaction with partner. From the supplier perspective, only one variable (TQMT) had a significant negative effect on satisfaction with partner, and from the overall perspective, only one variable (MU) had a significant positive effect on satisfaction with partner. Collinearity diagnostics (variance inflation factors: VIFs[7]) were within reasonable limits. Among the two variables from the customer perspective (TQMT and MU) having a positive effect, mutuality (MU) had a more significant effect on satisfaction with partner. From the overall perspective, a change of 0.49091 was expected associated with a unit change in MU. Conceptually, this result indicates higher levels of mutuality (MU: sharing rewards and benefits from joint action) were associated with higher levels of satisfaction with partners from both the customer and overall perspectives. Similarly, higher levels of joint use of tools (TQMT) were associated with higher partner satisfaction only from the customer perspective.

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[7] The VIFs represent the inflation that each regression coefficient experiences above ideal, i.e., above what would be experienced if the correlation matrix were an identity matrix. Though no rule of thumb on numerical values is foolproof, it is generally believed that if any VIF exceed 10, there is reason for at least some concern; then one should consider variable deletion or an alternative to least squares estimation to combat the problem (Myers, 1990, p. 360).

```
---------------------------------------- CUSTOMER ----------------------------------------

            Dependent Variable: SATISFACTION WITH PARTNERS

        Root MSE      0.93881      R-square     0.3328      Dep Mean     4.86364
        Adj R-sq      0.2653       C.V.         19.30257    F value      4.927
        Prob > F      0.0001


                     Parameter Estimates (Independent variables)

                        Parameter      Standard      T for H0:                    Variance
        Variable  DF     Estimate        Error      Parameter=0     Prob > |T|    Inflation

        INTERCEP   1     1.103787     0.84540031        1.306         0.1955      0.00000000
        DURA       1     0.005657     0.01132044        0.500         0.6187      1.04611569
        NoTOOL     1    -0.028132     0.02151364       -1.308         0.1948      1.07737260
        TQMT       1     0.287074     0.15591679        1.841         0.0693      1.88562526
        PRAC       1     0.126150     0.24185449        0.522         0.6034      4.19095852
        INFPRT     1     0.439856     0.27751778        1.585         0.1170      3.81206410
        RI         1    -0.316184     0.16788472       -1.883         0.0633      1.68047129
        CR         1    -0.450042     0.27331235       -1.647         0.1036      3.88503464
        MU         1     0.879970     0.26641683        3.303         0.0014      2.19399307


---------------------------------------- SUPPLIER ----------------------------------------

            Dependent Variable: SATISFACTION WITH PARTNERS

        Root MSE      1.03340      R-square     0.2431      Dep Mean     4.57895
        Adj R-sq      0.1527       C.V.         22.56842    F value      2.689
        Prob > F      0.0126


                     Parameter Estimates (Independent variables)

                        Parameter      Standard      T for H0:                    Variance
        Variable  DF     Estimate        Error      Parameter=0     Prob > |T|    Inflation

        INTERCEP   1     1.426061     1.53257279        0.931         0.3555      0.00000000
        DURA       1    -0.005451     0.00881883       -0.618         0.5386      1.06316209
        NoTOOL     1    -0.005531     0.02783475       -0.199         0.8431      1.04498606
        TQMT       1    -0.450615     0.21905761       -2.057         0.0436      1.94411670
        PRAC       1     0.405320     0.25605829        1.583         0.1181      2.63777958
        INFPRT     1     0.294077     0.33471481        0.879         0.3828      3.26467893
        RI         1     0.187214     0.25958112        0.721         0.4733      1.28373618
        CR         1     0.216496     0.25480344        0.850         0.3985      2.86108106
        MU         1     0.079022     0.33380585        0.237         0.8136      1.90113056
```

Figure 4-46. Regression Analysis: Satisfaction with Partners

```
---------------------------------------- OVERALL ----------------------------------------

                     Dependent Variable: SATISFACTION WITH PARTNERS

        Root MSE      1.01343       R-square      0.2127      Dep Mean      4.73171
        Adj R-sq      0.1721        C.V.          21.41776    F value       5.234
        Prob > F      0.0001


                      Parameter Estimates (Independent variables)

                         Parameter      Standard     T for H0:                      Variance
        Variable   DF     Estimate         Error    Parameter=0     Prob > |T|     Inflation

        INTERCEP   1      1.459663     0.75479404       1.934        0.0550        0.00000000
        DURA       1      0.001459     0.00669119       0.218        0.8277        1.10859254
        NoTOOL     1     -0.010789     0.01733935      -0.622        0.5347        1.03360510
        TQMT       1     -0.004832     0.13083319      -0.037        0.9706        1.86103474
        PRAC       1      0.265996     0.17706550       1.502        0.1351        3.35484074
        INFPRT     1      0.271092     0.21533247       1.259        0.2099        3.53319569
        RI         1     -0.148526     0.12516843      -1.187        0.2372        1.33853231
        CR         1     -0.066881     0.18345833      -0.365        0.7159        3.19869405
        MU         1      0.490910     0.21167982       2.319        0.0217        2.05380475
```

Figure 4-46. Regression Analysis: Satisfaction with Partners (cont.)

Unlike with the satisfaction with partner, different variables were identified as
sources of a significant *positive* effect on the level of overall partnership quality −
INFPRT from the customer perspective (borderline), PRAC from the supplier
perspective, and INFPRT (borderline) and PRAC from the overall perspective − with
reasonable collinearity diagnostics (see Figure 4-47). There was an expected change of
0.473419 in the level of overall quality of partnership associated with a unit change in
INFPRT from the customer perspective, while 0.670221 change was expected associated
with a unit change in PRAC from the supplier perspective. From the overall perspective,
0.334148 and 0.462574 changes were expected associated with a unit change in INFPRT
and PRAC respectively. Conceptually, this result indicates that higher levels of informed
partners (INFPRT) were associated with higher levels of partnership quality from both
the customer and overall perspectives. Similarly, higher levels of joint practice (PRAC)

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were associated with higher partnership quality from both the supplier and overall
perspectives.

```
------------------------------------ CUSTOMER ------------------------------------

                  Dependent Variable: OVERALL PARTNERSHIP QUALITY

          Root MSE      0.93030      R-square      0.3318      Dep Mean      4.70455
          Adj R-sq      0.2641       C.V.          19.77441    F value       4.903
          Prob > F      0.0001

                     Parameter Estimates (Independent variables)

                          Parameter        Standard     T for H0:                      Variance
           Variable  DF     Estimate          Error    Parameter=0     Prob > |T|      Inflation

           INTERCEP   1     0.565612      0.83773618         0.675         0.5015      0.00000000
           DURA       1     0.006007      0.01121782         0.535         0.5938      1.04611569
           NoTOOL     1    -0.007495      0.02131861        -0.352         0.7261      1.07737260
           TQMT       1     0.244745      0.15450330         1.584         0.1172      1.88562526
           PRAC       1     0.184575      0.23966192         0.770         0.4435      4.19095852
           INFPRT     1     0.473419      0.27500189         1.722         0.0891      3.81206410
           RI         1    -0.215521      0.16636273        -1.295         0.1989      1.68047129
           CR         1    -0.016522      0.27083459        -0.061         0.9515      3.88503464
           MU         1     0.251367      0.26400158         0.952         0.3439      2.19399307

------------------------------------ SUPPLIER ------------------------------------

                  Dependent Variable: OVERALL PARTNERSHIP QUALITY

          Root MSE      0.87870      R-square      0.3731      Dep Mean      4.42105
          Adj R-sq      0.2983       C.V.          19.87546    F value       4.985
          Prob > F      0.0001

                     Parameter Estimates (Independent variables)

                          Parameter        Standard     T for H0:                      Variance
           Variable  DF     Estimate          Error    Parameter=0     Prob > |T|      Inflation

           INTERCEP   1     0.677247      1.30315813         0.520         0.6050      0.00000000
           DURA       1    -0.017320      0.00749872        -2.310         0.0240      1.06316209
           NoTOOL     1    -0.008180      0.02366810        -0.346         0.7307      1.04498606
           TQMT       1    -0.282751      0.18626633        -1.518         0.1337      1.94411670
           PRAC       1     0.670221      0.21772829         3.078         0.0030      2.63777958
           INFPRT     1     0.375990      0.28461051         1.321         0.1910      3.26467893
           RI         1     0.285282      0.22072377         1.292         0.2006      1.28373618
           CR         1    -0.180500      0.21666128        -0.833         0.4078      2.86108106
           MU         1     0.023761      0.28383762         0.084         0.9335      1.90113056
```

Figure 4-47. Regression Analysis: Overall Quality of Partnership

```
----------------------------------------- OVERALL -----------------------------------------

                  Dependent Variable: OVERALL PARTNERSHIP QUALITY

       Root MSE      0.92370      R-square    0.2970      Dep Mean    4.57317
       Adj R-sq      0.2607       C.V.        20.19817    F value     8.186
       Prob > F      0.0001

                      Parameter Estimates (Independent variables)

                      Parameter       Standard     T for H0:                    Variance
         Variable  DF   Estimate          Error    Parameter=0    Prob > |T|    Inflation

         INTERCEP   1    0.969117    0.68796450        1.409        0.1609    0.00000000
         DURA       1   -0.006942    0.00609875       -1.138        0.2568    1.10859254
         NoTOOL     1   -0.005483    0.01580412       -0.347        0.7291    1.03360510
         TQMT       1    0.070229    0.11924921        0.589        0.5568    1.86103474
         PRAC       1    0.462574    0.16138811        2.866        0.0047    3.35484074
         INFPRT     1    0.334148    0.19626692        1.703        0.0907    3.53319569
         RI         1   -0.027242    0.11408601       -0.239        0.8116    1.33853231
         CR         1   -0.139641    0.16721491       -0.835        0.4049    3.19869405
         MU         1    0.142278    0.19293767        0.737        0.4620    2.05380475
```

Figure 4-47. Regression Analysis: Overall Quality of Partnership (cont.)

4.6.2   Levels of Joint Action (TQMT and PRAC)

The same regression procedures in Section 4.6.1 were used to determine whether
the following four variables – duration of partnership (DURA), average total annual sales
volume (ASV), the number of employees (EMPNO), and the number of tools/joint
practices used (identified by survey Items # 45 & 46; NoTOOL) – had an impact on the
levels of TQMT and PRAC. To do this, TQMT and PRAC were treated as dependent
variables and the above four variables were treated as independent variables. Figures 4-
48 and 4-49 show the results.

The results indicate that none of the four independent variables had a significant
positive effect on the levels of TQMT and PRAC. In addition, the p-value for the F-test
of each analysis in Figures 4-48 and 4-indicated a lock of significance of the overall
model.

```
---------------------------------------- CUSTOMER ----------------------------------------
                            Dependent Variable: TQMT
        Root MSE      0.89632      R-square      0.0412      Dep Mean     4.38652
        Adj R-sq     -0.0045      C.V.         20.43344     F value       0.902
        Prob > F      0.4665


                     Parameter Estimates (Independent variables)
                        Parameter      Standard      T for H0:                   Variance
        Variable  DF     Estimate        Error     Parameter=0    Prob > |T|    Inflation

        INTERCEP   1     4.049058     0.45486520        8.902        0.0001     0.00000000
        DURA       1     0.008072     0.00741048        1.089        0.2791     1.02819228
        ASV        1    -0.016878     0.07226587       -0.234        0.8159     1.83429792
        EMPNO      1     0.054035     0.05553746        0.973        0.3334     1.70127434
        NoTOOL     1     0.022338     0.02055438        1.087        0.2803     1.12949496

---------------------------------------- SUPPLIER ----------------------------------------
                            Dependent Variable: TQMT
        Root MSE      0.72633      R-square      0.0903      Dep Mean     4.30811
        Adj R-sq      0.0376      C.V.         16.85952     F value       1.713
        Prob > F      0.1571


                     Parameter Estimates (Independent variables)
                        Parameter      Standard      T for H0:                   Variance
        Variable  DF     Estimate        Error     Parameter=0    Prob > |T|    Inflation

        INTERCEP   1     3.892112     0.36335752       10.712        0.0001     0.00000000
        DURA       1    -0.006012     0.00643408       -0.934        0.3534     1.12709929
        ASV        1     0.058016     0.05897331        0.984        0.3287     1.92107734
        EMPNO      1     0.057471     0.05897851        0.974        0.3332     1.98557038
        NoTOOL     1    -0.004361     0.01920657       -0.227        0.8210     1.00658774

---------------------------------------- OVERALL ----------------------------------------
                            Dependent Variable: TQMT
        Root MSE      0.82133      R-square      0.0367      Dep Mean     4.35092
        Adj R-sq      0.0123      C.V.         18.87712     F value       1.506
        Prob > F      0.2030


                     Parameter Estimates (Independent variables)
                        Parameter      Standard      T for H0:                   Variance
        Variable  DF     Estimate        Error     Parameter=0    Prob > |T|    Inflation

        INTERCEP   1     3.872241     0.28620797       13.529        0.0001     0.00000000
        DURA       1     0.001325     0.00470820        0.281        0.7788     1.04154272
        ASV        1     0.035933     0.04571899        0.786        0.4331     1.88015913
        EMPNO      1     0.042441     0.03960599        1.072        0.2855     1.77830662
        NoTOOL     1     0.008095     0.01401665        0.578        0.5644     1.05571636
```

Figure 4-48. Regression Analysis: The Level of TQMT

```
-------------------------------------- CUSTOMER --------------------------------------
                            Dependent Variable: PRAC
          Root MSE      0.84502        R-square      0.0349      Dep Mean      4.71629
          Adj R-sq     -0.0111        C.V.         17.91706      F value       0.759
          Prob > F      0.5549

                    Parameter Estimates (Independent variables)
                         Parameter        Standard     T for H0:                    Variance
          Variable  DF    Estimate          Error     Parameter=0     Prob > |T|    Inflation

          INTERCEP   1    5.112154      0.42883366      11.921          0.0001      0.00000000
          DURA       1   -0.006770      0.00698638      -0.969          0.3353      1.02819228
          ASV        1   -0.043990      0.06813016      -0.646          0.5202      1.83429792
          EMPNO      1   -0.030507      0.05235910      -0.583          0.5617      1.70127434
          NoTOOL     1    0.019350      0.01937807       0.999          0.3209      1.12949496

-------------------------------------- SUPPLIER --------------------------------------
                            Dependent Variable: PRAC
          Root MSE      0.77351        R-square      0.0379      Dep Mean      4.41554
          Adj R-sq     -0.0179        C.V.         17.51786      F value       0.679
          Prob > F      0.6086

                    Parameter Estimates (Independent variables)
                         Parameter        Standard     T for H0:                    Variance
          Variable  DF    Estimate          Error     Parameter=0     Prob > |T|    Inflation

          INTERCEP   1    4.320083      0.38696110      11.164          0.0001      0.00000000
          DURA       1   -0.003993      0.00685204      -0.583          0.5620      1.12709929
          ASV        1    0.054281      0.06280420       0.864          0.3904      1.92107734
          EMPNO      1   -0.074582      0.06280974      -1.187          0.2391      1.98557038
          NoTOOL     1    0.007848      0.02045422       0.384          0.7024      1.00658774

-------------------------------------- OVERALL --------------------------------------
                            Dependent Variable: PRAC
          Root MSE      0.81421        R-square      0.0365      Dep Mean      4.57975
          Adj R-sq      0.0121        C.V.         17.77854      F value       1.489
          Prob > F      0.2058

                    Parameter Estimates (Independent variables)
                         Parameter        Standard     T for H0:                    Variance
          Variable  DF    Estimate          Error     Parameter=0     Prob > |T|    Inflation

          INTERCEP   1    4.651596      0.28372863      16.395          0.0001      0.00000000
          DURA       1   -0.008135      0.00466742      -1.743          0.0833      1.04154272
          ASV        1    0.017178      0.04532294       0.379          0.7052      1.88015913
          EMPNO      1   -0.044638      0.03926289      -1.137          0.2573      1.77830662
          NoTOOL     1    0.013822      0.01389523       0.995          0.3214      1.05571636
```

Figure 4-49. Regression Analysis: The Level of PRAC

4.7   *Summary of Overall Results*

The purpose of this chapter was to present results for the four research questions by using the methods described in Chapter 3. Table 4-46 shows the four research questions, a brief description of data analysis methods, and summary results obtained in this chapter. (Only results from the overall perspective are included in Table 4-46.)

In the following chapter, summary results in Table 4-46 and other findings in this chapter will be further analyzed to draw conclusions about q1-q3 relationships with respect to the four research questions.

Table 4-46. Overview of Research Questions, Data Analysis Methods, and Summary Results

Research question	Data analysis method	Summary results (From the overall perspective)
Research question #1: What joint tools and practices have been used by U.S. private manufacturing companies in q1-q3 joint action?	Average number of tools/joint practices How many tools/joint practices have been used by how many U.S. private manufacturing companies in their q1-q3 relationship? Frequency of each tool/joint practice used	Average number of tools and joint practices used: 9.1 6-10 and 0-5 tools and joint practices have been used by 75 (45%) and 41 (24%) companies 5 most frequently used tools and joint practices: supplier certification/verification, joint problem-solving teams, quality audit, JIT delivery/production, and joint planning 5 least frequently used tools and joint practices: quality circles, gainsharing, Quality Function Deployment, joint investment on R&D, and in-plant representative
Research question #2: Which tools and joint practices have been more effective and internalized in q1-q3 joint action?	One-way ANOVA: to test for any differences in the levels of effectiveness and internalization for each tool and joint practice Duncan multiple range test: to group those tools and joint practices whose effectiveness and internalization levels fell into the same range	Five tools and joint practices used most effectively: ISO 9000 and/or QS 9000 and/or Baldrige criteria, quality audit, JIT delivery/production, joint planning, and joint problem-solving teams Five tools and joint practices used least effectively: benchmarking, cost of quality, quality circles, gainsharing, and quality function deployment Five most internalized tools and joint practices: ISO 9000 and/or QS 9000 and/or Baldrige criteria, quality audit, JIT delivery/production, joint problem-solving teams, and supplier or customer performance measurement system Five least internalized tools and joint practices: cost of quality, gainsharing, quality circles, benchmarking, and quality function deployment
Research question #3: What is the relationship between tools and joint practices and shared results perceived by customer and supplier?	Two-way ANOVA: to determine if there is an interaction between two independent variables in examining their combined relationships with four dependent variables (significance level used : 0.1) One-way ANOVA: to test hypothesized relationships between each of two independent variables and each of four dependent variables	H1 (TQMT-INFPRT): supported H5 (PRAC-INFPRT): supported H2 (TQMT-RI): not supported H6 (PRAC-RI): supported H3 & H7 ((TQMT+PRAC)-CR): not supported H4 & H8 ((TQMT+PRAC)-MU): not supported
Research question #4: What changes (increase or decrease) in organizational performance dimensions (quality, cost, and cycle time) are perceived as a result of q1-q3 joint action and shared results?	Average perceived changes in three organizational performance dimensions Tools/joint practices used to improve/decrease three perceived organizational performance dimensions The overall effect on organizational performance	Quality: 30% increase; Cost: 21% decrease; and cycle time: 26% decrease For quality improvement: SPC, joint problem-solving teams, and quality audit For cost reduction: JIT delivery/production, joint problem-solving teams, and exchange of strategic information For cycle time reduction: JIT delivery/ production, joint planning, and exchange of strategic information
Supplementary results	Multiple regression analysis: to identify which variables have a significant effect on satisfaction with partners and overall quality of the partnership	MU was identified as having a positive significant effect on satisfaction with partners (Adj R^2=.1721, p<.0001) PRAC and INFPRT were identified as having a positive significant effect on overall quality of the partnership (Adj R^2=.1721.2607, p<.0001)

CHAPTER 5. CONCLUSIONS

The main purpose of this chapter is to draw conclusions from Chapter 4. To achieve the purpose, this chapter presents:

- Specific conclusions about tools/joint practices examined in Chapter 4 (Sections 5.1-5.5),

- Conclusions about changes in perceived organizational performance dimensions (Section 5.6) and contributing factors to satisfaction with partners and quality of the partnership (Section 5.7),

- Summary answers to the four research questions with respect to the three perspectives − customer, supplier, and overall − using the Operational Research Model (Section 5.8),

- Comparison of findings from this research to previous research (Section 5.9),

- Validity and contribution of this research (Sections 5.10 and 5.11),

- Limitations of this research (Section 5.12), and

- Areas for future research and overview of this research (Sections 5.13 and 5.14).

Conclusions described in this chapter are based on the findings derived from data collected from U.S. private manufacturing industries in SIC 35, 36, and 37 categories. In other words, generalization outside these industries may not be possible.

5.1   *Organizational Size and Number of Tools/Joint Practices Used*

Moch and Morse (1977) found that organizational size was positively associated with the frequency and amount of adoption of innovative technologies. In the context of this research, an organizational size may be measured by either the average total annual sales volume or the number of employees, or both. Also the frequency and amount of innovative techniques may be measured by the number of tools/joint practices used. Because both the company's average total annual sales volume and the number of employees are objective criteria for measuring organizational size, these two criteria can

be used to address whether or not Moch and Morse's assertion can be applied to the issues of organizational size vs. number of tools/joint practices used identified in this research.

However, from the results presented in Section 4.2.5, it is concluded that Moch and Morse's assertion on organizational size vs. frequency and amount of adoption of innovative technologies does not apply to the relationship between two organizational size measures (average total annual sales volume and number of employees) and the number of tools/joint practices used. From this conclusion, two points can be made. First, there is no significant effect from the two organizational size measures on the number of tools/joint practices used in customer-supplier relationships. Second, the number of tools/joint practices may not be a good measure of an organization's frequency and amount of adoption of technologies in the context of customer-supplier relationships.

5.2   *Most Frequently Used Tools/Joint Practices*

In Section 4.2, four tools/joint practices were identified as the most frequently used. These are supplier certification and verification, joint problem-solving teams, quality audits, and JIT production and delivery. In this section, conclusions about those tools/joint practices are drawn by closely examining their characteristics.

5.2.1   Supplier certification and verification & quality audits

A conclusion drawn regarding these two tools/joint practices is that customer organizations have frequently used quality audits as a means to certify or verify their suppliers. (This is why these two tools/joint practices are combined and considered together in this section.) Today, many customer organizations not only ask or require their suppliers to be certified by ISO 9000 or QS 9000 criteria, for example, but also maintain a list of preferred suppliers. The fact that both supplier certification/verification and quality audits were identified as two of the most frequently used tools/joint practices in this research supports the conclusion that quality audits have been used as one of the most common mechanisms to certify suppliers or to recognize suppliers' performance.

This conclusion is also supported by interview data. When asked to provide an example of joint action, two interviewees indicated

> *"We encourage our suppliers to use QS 9000 criteria and internal QS 9000 survey is used to measure our suppliers' performance." (1071[1])*

> *"More than 90% of our suppliers are ISO 9000 certified suppliers." (2071)*

Supplier certification is considered one of the specific investments made by either customer or supplier, or both, depending on which mechanism is used – internal or external quality audit. The investment can be made by the supplier because the supplier wants to remain on the customer's list of preferred suppliers by being certified by well-known criteria such as ISO 9000, QS 9000, or the Baldrige Award. Or the investment can be made by the customer because the customer wants to build and maintain a partnership with better suppliers by selecting only suppliers that are certified by the above mentioned criteria. Depending on who makes the investment and how they are to be certified, either internal or external quality audits can be used. (See Section A.1.2.1 for more information about internal and external quality audits.)

5.2.2 Joint problem-solving teams

Although the joint problem-solving team was identified as one of the most frequently used tools/joint practices, it is possible that the joint problem-solving team can be used in many different formats and for many different purposes, depending on the needs and wants of users. Joint problem-solving teams used in q1-q3 relationships may be used to document procedures that need corrective actions. As an example from this research, some of the additional tools/joint practices identified in survey Item # 46 relate to uses or application of joint problem-solving teams, e.g., warranty failure review meetings, corrective action documentation & process for validation (in Figure 4-11; from

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[1] In transcribing and using structured interview data, a four-digit coding scheme was used as follows to maintain the 'chain of evidence' (Miles & Huberman, 1984) by tracing back these qualitative responses/comments to structured interview questions. The first digit represents the number of interviewee (seven total). The second and third digits represent the question number in the interview guide. The fourth digit represents the perspective (either customer [1] or supplier [2]).

25 customers), and corrective action procedures (in Figure 4-15; from 15 suppliers). Interview data provide another example:

> *"One example of joint action we have used is joint problem-solving teams **to discuss problems and future improvement issues**." (5072)*

A conclusion drawn from the findings from the survey responses and interview data mentioned above is that the focus of joint problem-solving teams used in q1-q3 relationships may be on reviewing and preparing corrective action procedures or documents, including warranty failure, not on actually designing corrective actions. Although it was not specifically addressed nor discovered in this research who actually designs corrective actions, it is assumed, based on the above finding and conclusion, that corrective actions are actually designed and implemented by managers and engineers in either R & D or operations/production, while corrective action procedures are reviewed, documented, and modified by managers responsible for the buying and selling functions of the organization.

5.2.3 JIT delivery/production

Another conclusion drawn from this research is that JIT delivery/production appears to be used frequently not only to streamline both delivery (from suppliers to customer) and production (in customer organizations) systems, but also to automate several related operations such as ordering and scheduling by using EDI or paperless business operations.

The fundamental concept of JIT is eliminating waste caused by overproduction, unnecessary handling, inefficient processing, and defective production (Japan Management Association, 1986). The finding about JIT delivery/production in this research not only supports this fundamental concept of JIT, but also implies another concept: paperless operations using Electronic Data Interchange (EDI). In Figures 4-11 and 4-15, 25 customers and 15 suppliers identified additional tools/joint practices used in their q1-q3 relationships. Some examples that relate to the JIT concept are (1) vendor managed stocking programs, (2) cycle time reduction, (3) kanban system, (4) on-time

delivery, (5) delivery to line sequence, (6) EDI (2 responses), and (7) electronic order & schedule sharing & placement. The first 5 of these additionally identified tools/joint practices are used to eliminate the different types of waste mentioned earlier. In addition, an effort to manage paperless business operations using more EDI technology can also be found in the last two responses. This point is also supported by the interview data. Some future trends in q1-q3 relationships identified by two interviewees include

- *"paperless operations" (3201)*
- *"paperless transactions" (3201) and*
- *"wireless communications" (4202)*

A relationship between the second and the fourth conclusions can also be derived. Frequent delivery of defect-free materials is one important objective of JIT delivery/ production. One way to meet this objective is to eliminate the receiving inspection of incoming materials. The elimination of the receiving inspection can be done by supplier certification in conjunction with a quality audit of an organizational upstream system. When suppliers consistently meet the quality standard set by both the customer and supplier, the customer organization does not need to conduct a traditional receiving inspection.

5.3   *Least Frequently Used Tools/Joint Practices*

A conclusion drawn in this research that relates to the least frequently used tools/joint practices is the four least frequently used tools/joint practices identified in Section 4.2 seem to be either intra-organizational tools/joint practices, or be used more by other functions of the organization than by q1-q3 relationships.

In the case of quality circles, it has been used primarily in an intra-organizational, not inter-organizational, context. For example, today, many companies have more teams, such as quality circles and other types of self-directed or self-managed teams than in the past, that meet on a regular basis to discuss improvement issues and solve problems they encounter to improve quality and productivity. Most, if not all, activities in these team types have been done in an intra-organizational or inter-departmental environment within

the same organization, not between two different organizations. In this sense, the quality circle can be considered an intra-organizational planning or problem-solving team.

In the case of gainsharing, organizations seem to have used other types of sharing gains or benefits. This is evidenced by the interview data. For example, one interviewee said:

> *"My company has shared cost savings and benefits with suppliers by giving them more business, not by directly sharing monetary rewards with suppliers." (5181)*

Another interviewee also indicated:

> *"My company has divided benefits evenly not by sharing resulting benefits, but by saving money and time independently from each other by using JIT delivery systems." (2181)*

In other words, organizations have shared gains and benefits resulting from joint action by mechanisms other than those by which two organizations physically divide monetary gains.

On the other hand, QFD has been used in an inter-organizational context. However, most research on the use of QFD has been limited to designing and manufacturing parts and components by engineers from two organizations, not by managers of buying and selling functions. Examples are abundant: Cohen (1988), Fortuna (1988), Hauser and Clausing (1988), Hauser (1993), Sullivan (1996, 1988), and De Vera (1988). All QFD practices introduced in the above literature are used by engineers of either two different companies or two different functions of the same company such as design and manufacturing. One source that examined the use of QFD in the context of q1-q3 relationships (Modarress, 1994) suggests the role of suppliers from theoretical perspectives. It does not provide empirical evidence about how to use QFD and the benefits of using QFD in q1-q3 contexts.

Lastly, joint investment on R & D was identified as one of the least frequently used tools/joint practices. However, it should be noted that different types of joint investments, such as joint ventures and evaluation of alternate materials and joint technology development, were identified by the interviewees as a part of a future trend in

q1-q3 relationships. In other words, it is expected that customer and supplier organizations will invest more resources on joint R & D activities, although they have not frequently engaged in joint investment activities so far.

5.4   Use of ISO 9000 and/or QS 9000 and/or Baldrige Award Criteria

In this section, a conclusion about the use of ISO 9000 and/or QS 9000 and/or the Baldrige Award criteria is drawn in two aspects: (1) it was not one of the most frequently used tools/joint practices, but was one of the most effective; and (2) customers' level of internalization was higher than suppliers'.

5.4.1   Used not frequently but used most effectively

One possible reason for this frequency vs. effectiveness issue can be answered by the length of time that this set of standards and criteria have been known and utilized by U.S. companies.

ISO 9000, which is a series of three international standards and supplementary guidelines on quality management and quality assurance, was first published in 1987 and revised in 1994. QS 9000 was developed in 1994 by the big three U.S. automotive manufacturing companies. The Baldrige Award was first introduced to U.S. companies in 1987. In other words, compared to other frequently used tools/joint practices such as JIT delivery/production and joint problem-solving teams that have existed for more than two decades, all three quality standards and criteria have been known and used by U.S. companies for less than 10 years. On the other hand, in Section 5.2.3, it was mentioned that supplier certification/verification in conjunction with a quality audit has been used very frequently by U.S. companies. In addition, in Section 4.3, it was found that ISO 9000 and/or QS 9000 and/or Baldrige Award have been used most effectively by U.S. companies.

The fact that the above three quality standards and criteria have existed in the U.S. for less than 10 years and that many U.S. companies rely on quality audits very frequently can explain why this specific set of quality standards and criteria have been used less frequently, but have been used the most effectively. Another reason why this

set of quality standards and criteria has been used the most effectively may be also explained by the level of clarity of documentation in terms of what and how to do. Because the methods and procedures to use these quality standards and criteria are relatively clearly documented in guidelines such as ISO 9000 and QS 9000 guidelines and the Baldrige application, companies could use them more effectively than other tools/joint practices. In other words, methods and procedures for other tools/joint practices such as quality circles and QFD tend to be less detailed and may be more dependent on specific q1-q 3 situations.

5.4.2   Customers' level of internalization is higher than suppliers'

In Section 4.3, it was also found that the customers' level of internalization for this set of standards and criteria is included in the first Duncan grouping, while the suppliers' internalization level is included in the third Duncan grouping. This may be due to the costs associated with using this set of tools/joint practices to certify supplier companies via quality audits. (In the case of internal audits, the supplier conducts quality audits by themselves either by hiring an external auditor or a team of auditors, or by using a team of its own people. However, in case of external audits, the customer either hires external auditors to audit their suppliers, or the customer audits the suppliers directly.)

Whatever type of audit is used, it costs either the supplier or the customer organization, or both, to certify suppliers. The amount of cost usually depends on two factors; first, the current level of quality systems in supplier companies, and second, the overall organizational size measured by the number of employees. For example, Lamprecht (1992) estimated costs associated with quality audits using ISO 9000 standards as follows:

> *"Some companies have invested as much as a $100,000, others much less and still others substantially more. Excluding training and preparation, the cost of registration and implementation for a 100-300 employee site can range anywhere from $26,000 to $45,000"* (p. 117).

Based on the estimated costs and on previous findings about the relatively small organizational size of supplier companies' in terms of number of employees, the following conclusion is derived. Because of the relatively smaller organizational size, supplier organizations may not want to spend money to be certified and re-certified at least once a year, or they cannot afford the cost. This may explain why this set of quality standards and criteria has been less internalized in supplier organizations than in customer organizations.

5.5   *Joint Action and Shared Results*

In this section, conclusions about the hypothesized relationships between independent and dependent variables are drawn.

5.5.1   Joint action and informed partners (INFPRT)

In Section 4.4, it was found that the relationship between joint action and informed partners (INFPRT) was supported from the customer perspective (TQMT+PRAC and INFPRT), and not supported (TQMT-INFPRT) or supported (PRAC-INFPRT) from the supplier perspective. A set of conclusions can be drawn from this observation. First, organizations with higher levels of TQMT maintain either higher degrees of INFPRT or low degrees of INFPRT. This is because the combined relationship between TQMT and PRAC and INFPRT (combined H1 and H5) was supported from the customer perspective and because the relationship between TQMT and INFPRT (H1) was not supported from the supplier perspective. Second, organizations with higher levels of joint practices (PRAC) maintain higher degrees of INFPRT (combined H1 and H5: supported from the customer perspective and H5: supported from the supplier perspective).

From this finding, a conclusion is drawn as follows. To some extent, organizations with higher levels of joint action exchange not only minimal amounts of information, such as product specifications, basic prices/costs, and delivery schedules that could also be found in transaction-oriented, traditional q1-q3 relationships, but also other types of information, including technical support in substantial detail, cost

reduction ideas and opportunities, and even future events and changes such as long-range forecasts of supply capabilities or demand requirements that may affect the other party.

Evidence of support for the hypothesis (H1 & H5 from the customer perspective and H5 from the supplier perspective) and the conclusion is also found in additional tools/joint practices identified by customers and suppliers in Figures 4-11 and 4-15 (survey Item # 46). Some tools/joint practices, such as (electronic) schedule sharing, status update, value analysis/engineering, are examples of tools/joint practices used in q1-q3 relationships before a partnership is established. However, other tools/joint practices such as new product introduction (early supplier involvement in design, test, and manufacturing), manufacturability review, and sharing unusual costs, may not be expected in arm's length, traditional, and non-partner q1-q3 relationships.

These additionally identified tools/joint practices also imply that INFPRT defines a bilateral expectation that customers and suppliers will proactively share/provide information/suggestions useful to each other. To the supplier, INFPRT represents a safeguard in the sense that the customer is expected to provide unforeseen information that may affect supplier operations. This is because an expectation of getting useful information on an ongoing basis enables the supplier to cope better with the vulnerability associated with transferring decision-making control to the customer, and vice versa. The high degrees of INFPRT can only be found in q1-q3 relationships that are characterized by higher levels of joint action and partnerships.

A similar finding was found in Anderson and Weitz's (1992) study in which 378 buyer-seller dyads among five Fortune 500 companies were examined. They found that one of the key factors of joint action used in this research – specific investments – is positively related to both customer and supplier commitment to sharing strategic information. By sharing strategic information or informing each other of improvement ideas and opportunities can both parties increase quality and productivity, reduce cost, and better meet requirements and needs of the other party.

5.5.2 Joint action and role integrity (RI)

In Section 4.4, the hypothesized relationship between joint action and role integrity (RI) was not supported from both customer (combined TQMT+PRAC and RI) and supplier perspectives (TQMT-RI and PRAC-RI). In other words, both customer and supplier organizations with higher levels of joint action do not maintain high degrees of RI.

In theory, RI is described as follows. The more discrete the transaction (*or* the more the relationship is based only on business transactions), the more simplistic become the roles to be maintained by both parties (Macneil, 1983). By contrast, relational exchange, or partnership, requires the parties to maintain highly complex and multi-dimensional roles (Macneil, 1980 and 1978). In the context of this theory on RI, no support for the hypothesis, particularly from supplier perspective, can be explained by one of the findings in Section 4.1: the suppliers' tendency to maintain a long-term relationship with multiple source partners. In other words, if suppliers prefer maintaining multiple sources of partners to maintaining a single source, they are likely to rely on other sources of partners which, in turn, results in lower degrees or uni-dimensional role complexities as well as lower level of continuity expectations of the customer.

A similar point was made in Hu and Chen's (1993) study where the degree of joint venture, which is considered a part of role integrity, was examined with respect to socio-cultural distance between partners. They found that firms seek low degrees of joint venture under conditions of high socio-cultural distance. In the context of this research, it is likely that both parties experience higher degrees of socio-cultural distance, or low degrees of role integrity, if suppliers maintain a relationship with multiple customers than when they establish a partnership with only a few (or single) customers.

5.5.3 Joint action and conflict resolution (CR)

From the hypothesized relationships between joint action and conflict resolution (CR), it is concluded that customers and suppliers have different perceptions about this particular shared result dimension. For example, the hypothesized relationships TQMT-CR and PRAC-CR were supported from the customer perspective, which means that as

the use of joint tools and practices increases, customers perceived that conflicts were resolved less formally. On the other hand, from the supplier perspective, higher levels of joint action were not found to be associated with more informal conflict resolution.

Osborn and Baughn (1990) made a point that is moderately aligned with the supplier perspective in this research. In their study where the relationship between environmental uncertainty and contractual agreement was examined using 153 U.S.-Japan alliances, they found that alliances are likely to be governed by contractual agreements under conditions of environmental uncertainty. In the context of this research, the use of contractual agreement, which is considered a formal mechanism to do business, or resolve conflicts, is likely to increase if customers feel uncertain, or insecure, future relationship with their suppliers. This is true especially when suppliers tend to maintain a relationship with multiple sources of other customers.

5.5.4   Joint action and mutuality (MU)

The hypothesized relationships between joint action (TQMT+PRAC) and MU and between each TQMT and PRAC and MU were not supported from the customer and supplier perspective respectively. Higher levels of joint action did not seem to be associated with higher levels of mutuality (sharing rewards and benefits from joint action) from the both perspectives.

As identified from structured interview data, it appears that organizations, especially customer organizations, are not willing to equally distribute cost savings and other benefits from the relationship with suppliers. However, different findings are identified by Bucklin and Sengupta (1993) and Heide and John (1988). These two studies found that specific investments, which is one of the key factors of joint action, is positively related to the degree of equal sharing of benefits and expenses over the long-term business transaction horizon.

5.6   Changes in Perceived Organizational Performance Dimensions

In Section 4.4, it was found that different tools/joint practices have been used to improve each of the three perceived performance dimensions – quality, cost, and cycle time – as follows (see Tables 4-45 and 4-46):

- Statistical process control, joint problem-solving teams, and quality audits have been used to improve perceived quality (customer: 31%, supplier: 28%, and overall: 30%),

- JIT delivery/production and joint problem-solving teams have been used to reduce perceived cost (customer: 24%, supplier: 18%, and overall: 21%), and

- JIT delivery/production, joint problem-solving teams, and exchange of strategic information have been used to reduce cycle time (customer: 28%, supplier: 23%, and overall: 26%).

It appears that managers have used joint problem-solving teams more frequently than other tools/joint practices as a means for improving all three performance dimensions.

A next question is: How much are these improvements in *perceived* organizational performance dimensions different from improvements in the same organizational performance dimensions *measured objectively* by other researchers? However, no conclusion regarding this comparison cannot be made (e.g., improvements in this research appear higher) for the following two reasons. First, operational measures used to determine the degree or amount of improvement in the three performance dimensions may be different between this research and previous studies. Second, because organizational performance improvements identified in this research were perceptions of participants in the mailed survey questionnaire, it cannot be concluded that improvements resulting from the use of tools/joint practices are higher in this research as compared to previous studies.

5.7   *Contributing Factors to Satisfaction with Partners and Quality of the*
         Partnership

From the results from multiple regression analysis presented in Section 4.6, a
conclusion can be drawn. It appears that the customer's and supplier's levels of
satisfaction with partners are influenced by different factors and in different ways. For
example, three factors – TQMT, RI, and MU – were identified as having a significant
impact on the customer's satisfaction with partners, while only one factor – TQMT – was
identified as having a significant impact on the supplier's satisfaction with partners. In
addition, the same factor – TQMT – was identified to have a positive impact on the
customer's satisfaction with partner and a negative impact on the supplier's satisfaction
with partner. One reason may be that some suppliers may feel forced to use specific tools
by their customer, which, in turn, has caused a negative impact on the supplier's
satisfaction with their customers. The supplier's use of tools by pressure from their
customers is likely to result in a negative contribution to their satisfaction with partners
because of the feeling of involuntary participation and inequality or unfairness.

A similar phenomenon was found in identifying contributing factors to the overall
quality of the partnership. Two different factors were identified as having a significant
impact on the customer's and supplier's perceived, overall quality of the partnership:
INFPRT for customers and PRAC for suppliers. It seems that customers' partnership
quality is affected by suppliers' willingness to share useful information or commitment to
provide performance specific suggestions, while suppliers' partnership quality is affected
by more frequent personal contacts with customers for joint planning, joint problem-
solving, and exchange of strategic information.

5.8   *Summary of This Research*

In this section, all answers to the four research questions are combined and
summarized using three perspectives: customer, supplier, and overall. To do this, all
components of the Operational Research Model in Figure 3-4 are replaced with key
results relating to the research questions. Figures 5-1, 5-2, and 5-3 show the summary.

The three figures show similarities and differences among the three perspectives − customer, supplier, an overall − in terms of how and which tools/joint practices were used (Research Questions #1 and 2), how the eight hypothesized relationships between independent and dependent variables were perceived (Research Question #3), and specific and overall changes (improvements) in organizational performance dimension (Research Question #4) perceived by each perspective. (Combined TQMT and PRAC effect is indicated by two merging arrow heads pointing at the same dependent variable (e.g., [TQMT+PRAC]-INFPRT and [TQMT+PRAC]-MU in Figure 5-1), while separate effect from either TQMT or PRAC is indicated by single arrow head (e.g., TQMT-RI, PRAC-RI, TQMT-CR, and PRAC-CR in Figure 5-1).)

JOINT ACTION

•**Most frequently used tools/joint practices**: Supplier certification/verification, Joint problem-solving teams, Quality audit, JIT production/delivery, and Supplier or customer performance measurement system

•**Least used tools/joint practices:** Quality Function Deployment, Quality circles, Gainsharing, Joint investment on R&D, Cost of quality, and Joint quality education/training

•**Most effective tools/joint practices**: JIT production/delivery, Joint problem-solving teams, Joint planning, Quality audit, and ISO 9000 and/or QS 9000 and/or Baldrige criteria

•**Least effective tools/joint practices**: Benchmarking, Cost of quality, Gainsharing, Quality circles, and Quality function deployment

•**Most internalized tools/joint practices**: JIT production/delivery, Joint problem-solving teams, Quality audit, Supplier or customer performance measurement system, and ISO 9000 and/or QS 9000 and/or Baldrige criteria

•**Least internalized tools/joint practices**: Benchmarking, Cost of quality, Gainsharing, Quality circles, and Quality function deployment

•**Average number of tools/joint practices used**: 9.3

TQMT	PRAC

Combined effects

Separate effects

Support

Not support

INFPRT	RI	CR	MU

SHARED RESULTS

Changes in Perceived Organizational Performance

Quality improvement: 31%
Cost reduction: 24%
Cycle time reduction: 28%
Overall improvement: 25%

Figure 5-1. Summary Results (Customer)

JOINT ACTION

•**Most frequently used tools/joint practices**: Supplier certification/verification, Joint problem-solving teams, Statistical process control, Joint planning, Quality audit, and JIT production/delivery

•**Least used tools/joint practices:** Quality Function Deployment, Quality circles, Gainsharing, Joint investment on R&D, In-plant representative, and Joint quality education/training

•**Most effective tools/joint practices**: Quality audit, JIT production/delivery, ISO 9000 and/or QS 9000 and/or Baldrige criteria, Joint planning, Joint problem-solving teams, and supplier certification or verification

•**Least effective tools/joint practices**: Benchmarking, Cost of quality, Gainsharing, Quality circles, and Joint investment on R & D

•**Most internalized tools/joint practices**: JIT production/delivery, Quality audit, Supplier or customer performance measurement system, ISO 9000 and/or QS 9000 and/or Baldrige, and Supplier certification or verification

•**Least internalized tools/joint practices**: Benchmarking, Gainsharing, Quality circles, Joint investment on R & D, and Quality function deployment

•**Average number of tools/joint practices used**: 8.9

TQMT	PRAC

Combined effects

Separate effects

Support

Not support

INFPRT	RI	CR	MU

SHARED RESULTS

Changes in Perceived Organizational Performance

Quality improvement: 28%
Cost reduction: 18%
Cycle time reduction: 23%
Overall improvement: 25%

Figure 5-2. Summary Results (Supplier)

JOINT ACTION

•**Most frequently used tools/joint practices**: Supplier certification/verification, Joint problem-solving teams, Quality audit, JIT production/delivery, Joint planning, and Statistical process control

•**Least used tools/joint practices:** Quality Function Deployment, Quality circles, Gainsharing, Joint investment on R&D, and In-plant representative

•**Most effective tools/joint practices**: ISO 9000 and/or QS 9000 and/or Baldrige criteria, Quality audit, JIT production/delivery, Joint problem-solving teams, Joint planning, Supplier or customer performance measurement system

•**Least effective tools/joint practices**: Benchmarking, Cost of quality, Gainsharing, Quality circles, Quality function deployment, and Joint investment on R & D

•**Most internalized tools/joint practices**: JIT production/delivery, Quality audit, ISO 9000 and/or QS 9000 and/or Baldrige, and Supplier or customer performance measurement system

•**Least internalized tools/joint practices**: Benchmarking, Cost of quality, Gainsharing, Quality circles, Joint investment on R & D, and Quality function deployment

•**Average number of tools/joint practices used**: 9.1

TQMT	PRAC

Combined effects

Separate effects

Support

Not support

INFPRT	RI	CR	MU

SHARED RESULTS

Changes in Perceived Organizational Performance

Quality improvement: 30%
Cost reduction: 21%
Cycle time reduction: 26%
Overall improvement: 25%

Figure 5-3. Summary Results (Overall)

To compare the customer and the supplier perspectives, tools/joint practices in Figures 5-1, 5-2, and 5-3 are combined and portrayed differently in Table 5-1.

Table 5-1. Tools/Joint Practices from Figures 5-1, 5-2, and 5-3

Tools/joint practices	Customer	Supplier	Overall
Most frequently used	Supplier certification/verification Joint problem-solving teams Quality audits JIT delivery/production Supplier or customer performance Measurement system	Supplier certification/verification Joint problem-solving teams Statistical process control Joint planning Quality audits JIT delivery/production	Supplier certification/verification Joint problem-solving teams Quality audits JIT delivery/production Joint planning Statistical process control
Least frequently used	Quality Function Deployment Quality circles Gainsharing Joint investment on R & D Cost of quality Joint quality education/training	Quality Function Deployment Quality circles Gainsharing Joint investment on R & D In-plant representative Joint quality education/training	Quality Function Deployment Quality circles Gainsharing Joint investment on R & D In-plant representative

Most effective	JIT delivery/production
	Joint problem-solving teams
	Joint planning
	Quality audits
	ISO 9000 and/or QS 9000 and/or
	    Baldrige criteria
		Quality audits
		JIT delivery/production
		ISO 9000 and/or QS 9000 and/or
		    Baldrige criteria
		Joint planning
		Joint problem-solving teams
		Supplier certification/verification
			ISO 9000 and/or QS 9000 and/or
			    Baldrige criteria
			Quality audits
			JIT delivery/production
			Joint problem-solving teams
			Joint planning
			Supplier or customer performance
			    Measurement system

Least effective	Benchmarking Cost of quality Gainsharing Quality circles Quality Function Deployment	Benchmarking Cost of quality Gainsharing Quality circles Joint investment on R & D	Benchmarking Cost of quality Gainsharing Quality circles Joint investment on R & D

Most internalized	JIT delivery/production
	Joint problem-solving teams
	Quality audits
	Supplier or customer performance
	    Measurement system
	ISO 9000 and/or QS 9000 and/or
	    Baldrige criteria
		JIT delivery/production
		Quality audits
		Supplier or customer performance
		    Measurement system
		ISO 9000 and/or QS 9000 and/or
		    Baldrige criteria
		Supplier certification/verification
			JIT delivery/production
			Quality audits
			ISO 9000 and/or QS 9000 and/or
			    Baldrige criteria
			Supplier or customer performance
			    Measurement system

Least internalized	Benchmarking Cost of quality Gainsharing Quality circles Quality Function Deployment	Benchmarking Gainsharing Quality circles Joint investment on R & D Quality Function Deployment	Benchmarking Cost of quality Gainsharing Quality circles Joint investment on R & D Quality Function Deployment

To highlight differences between the customer and the supplier perspectives, tools/joint practices that were identified by only one perspective are shaded. In addition to the findings and conclusions presented in Chapters 4 and 5, the following additional conclusions can be drawn from Table 5-1:

- Cost of quality was identified by only customers as both the least frequently used and the least internalized. This finding seems to imply that customers are not as

concerned with measuring costs associated with quality. This phenomenon may be expected in q1-q3 relationships because, in most cases, the supplier is the party that supplies parts and components to its customers, and after the delivery, is impacted by the customer's reaction if the supplier did not meet the customer requirements. Non-conformance to customer requirements may encourage or force the supplier to use cost of quality to take corrective actions in order to prevent additional costs from being incurred.

- Supplier verification/certification was identified only by suppliers as one of the most effective and the most internalized tool/joint practice. From this finding, it may be concluded that either the supplier's desire to be certified is higher than the customer's expectation of their suppliers to be certified, or the supplier has recognized the need for or importance of being certified in the current environment.

Overall, the customer and the supplier identified almost the same set of tools/joint practices for each category in Table 5-1 except for the above two cases. For example, both perspectives identified exactly the same set of tools/joint practices − benchmarking, cost of quality, gainsharing, quality circles, and joint investment on R & D − as the least effectively used ones.

5.9   *Comparison to Previous Studies*

The purpose of this section is to identify similarities or differences between this research and previous studies by comparing results and findings.

5.9.1   Comparison to Management Systems Engineering literature

In her study to provide an operational definition of TQM implementation, Pang (1990) identified five interventions as a means for managing upstream systems: (1) understanding the market, (2) deploying information from functions into product designs, (3) working with suppliers or venders as partners, (4) certifying suppliers, and (5) communicating requirements and expectations clearly with suppliers. The fourth intervention, certifying suppliers, identified by Pang was also a component of the answers to Research Questions #1 (most and least frequently used tools/joint practices) and #2

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(the level of effectiveness and internalization) in this research: supplier certification/ verification was identified in this research as one of the most frequently used and most effective and internalized tools/joint practices.

Pang also identified three interventions for downstream systems: (1) managing customer perception, (2) achieving customer satisfaction, and (3) going beyond customer satisfaction. Although these three interventions were not used or identified in this research in answering the four research questions, suppliers may be able to use specific performance dimensions that measure the customer perception or satisfaction levels in their performance measurement systems.

5.9.2   Comparison to purchasing literature

Tables 2-6 and 2-7 summarized tools/joint practices and resulting performance improvements from using them from 15 previous studies. One finding from these tables was that five tools/joint practices have been used the most frequently in both the manufacturing and service industries. The five tools/joint practices are (1) QFD, (2) JIT purchasing, (3) supplier performance evaluation, (4) joint problem-solving activities, and (5) education and training programs. JIT purchasing relates very closely to JIT delivery/production that was identified in this research as one of the most frequently used and most effective and internalized tools/joint practices. Supplier performance evaluation relates to supplier performance measurement system, identified as one of the most internalized tools/joint practices in this research. The joint problem-solving activities identified in Tables 2-6 and 2-7 may be considered as a different term for joint problem-solving teams, identified in this research as one of the most frequently used and most effective and internalized tools/joint practices. However two remaining tools/joint practices shown in Tables 2-6 and 2-7 – QFD and education & training – were not identified in this research as the most frequently used or the most effective and internalized. One possible reason for this may be due to the different data sources: SIC 35, 36, and 37 U.S. private manufacturing companies in case of this research, vs. the overall U.S. manufacturing and service industries in case of Tables 2-6 and 2-7.

5.9.3 Comparison to marketing-relationalism literature

It is difficult to compare findings from this research with those from previous relationalism studies from which major constructs used in this research were obtained. This is because of the different purpose, focus, and approaches selected by this research, in comparison to previous relationalism studies. However, the following two[2] major findings from relationalism studies are selected to compare findings from this research.

First, in their study in examining associations with strength of buyer-seller relationships (relationalism) and alternative governance structures (market, administered, franchise, and corporate), Boyle et al. (1992) identified that the frequency of recommendations, promises, and information exchange is associated positively with a global measure of relationalism. In the context of this research, frequent recommendations, promises, and information exchange can be considered as a set of tools/joint practices contributing to informed partners (INFPRT). In addition, the relationship between joint action and INFPRT was found in this research to be supported by customers. Therefore findings in this research about the relationship between joint action and INFPRT are in agreement with findings from Boyle et al.

Second, Heide and John (1992) showed norms (defined by them as expectations about behavior that are at least moderately shared by a group of decision makers) play a very significant role in structuring economically efficient relationships between independent firms. In context of this research, norms can be considered as expectations anticipated by each party in terms of sharing/providing information/suggestions for INFPRT, multi-dimensional and more complex roles (RI), or even sharing of benefits and cost savings fairly (MU). However, some findings from the hypothesized relationships

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[2] Other studies are not used because the nature (research objectives, purposes, and approaches) of and findings from them are so different from this research that comparison would not reveal any significant facts. For example, Dant and Schul (1992, p. 38) revealed a high overall incidence of the integrative problem-solving approach, but a preference for third-party intervention when the disputed issues involve high stakes, complexity, and policy connotations and when the franchise dependency is rated high. Also, Kaufmann and Dant (1992) provided support for a multidimensional construction of the governance of commercial exchange relationships using several constructs such as relational focus, solidarity, role integrity, and the relationships among these constructs, not the relationship between joint action and these constructs.

between joint action and these three shared results dimensions do not align with Heide and John's assertion. This may be caused by the different research settings selected by Heide and John such as: (1) different scale (buyer control, buyer-specific assets, norm of solidarity, etc.) and survey items (2) different data source (OEM manufacturers and their component suppliers from SIC 35, 36, and 37), and (3) different research objectives and questions.

5.10   Validity of This Research

The results, findings and conclusions presented in this research are based on 172 mailed survey questionnaire responses (overall response rate: 9.78%) and qualitative data from 7 structured interviews. The question of whether or not this research has sufficient validity can be addressed by comparing other similar, previous studies that were published in well-known journals in relationalism and quality management areas. The following are some examples.

- Heide and John's study (*Journal of Marketing*, 1992) used 1,157 purchasing agents/directors of SIC 35, 36, and 37 manufacturers, with response rate of 13.4% (155/1,157). Although the response rate of their study is higher than the response rate of this research, their study findings were not supported by any qualitative research data such as the interviews that were used in this research.

- In their study, Kaufman and Stern (*Journal of Conflict Resolution*, 1988) used 32 real cases of customer-supplier relationships in which any types of lawsuits were filed, suggesting that norms that govern commercial exchange behavior in discrete transactions are markedly different from those in relational exchange.

- To identify specific advantages of JIT purchasing, Radovilsky (*Industrial Management*, 1996) used 67 companies in the San Francisco Bay area. Compared to his study, this research used a broader range of responses in terms of both the number of responses (172 vs. 67) and geographic dispersion (U.S. overall vs. San Francisco).

In addition to the comparable response rate of this research to the studies mentioned above, the expertise and knowledge reflected in the sample is believed to be high. This is because the majority of returned survey questionnaires (117 out of 172)

came from ASQ-CSD members who have expertise and firsthand experience of q1-q3 relationships. In addition, all 7 individuals who were interviewed in this research were in charge of one of the buying, selling, or quality-related functions of their companies. Therefore, it is believed the quality of the data provided by this sample provides evidence of overall validity of the study findings.

Another validity-related issue relates to the rate of the sample from the population used in the mailed survey questionnaire. The total population of U.S. private manufacturing companies in SIC 35, 36, and 37 categories is approximately 3,000. This population was sampled by sending survey questionnaires to 1,811 of these companies, which is more than half the population, and this study actually sampled 6% of the total population[3].

Based on the three validity issues mentioned in this section – response rate, quality of research data, and rate of the sample from the population – the responses to the mailed survey questionnaire as well as structured interview data were sufficient to consider results and findings representative of the population, and can be generalized to this population with a high degree of confidence. However, as mentioned earlier in this chapter, conclusions described in this chapter may not necessarily be generalized to other populations (non-SIC 35, 36, and 37 industries) (external validity or generalizability) without modifications because results and findings from this research were based on SIC 35, 36, and 37 industries.

In addition to external validity, three other forms of validity related to this research can be addressed: face validity, content validity, and construct validity. Content validity was addressed by the way in which survey items were developed – their linkage to existing literature and previous research. Face validity was addressed, and improved, through seeking feedback on item wording and hearing in the pilot study (see Appendix D). Evidence of construct validity was provided in Chapter 3 (see Section 3.5) – how

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[3] The number of U.S. private manufacturing companies registered in the *Directory of Corporate Affiliations* under the category of SIC 35, 36, and 37 was 2,983 in 1996. The population size – 2,983 – means the overall response rate in this study from the population is approximately 6% (172/2,983).

items were evaluated together to represent meaningful constructs.

5.11   *Contribution of This Research*

This research makes three contributions to knowledge in the area of supply management practices and research. First, this research is the first attempt of which the researcher is aware to explore the shared results of joint action between q1 and q3 organizations to build and expand knowledge on upstream management systems. In doing so, the researcher has attempted to deal with a set of four shared results dimensions as dependent variables. It is also the first attempt of which the researcher is aware to treat integrated shared results dimensions as a set of dependent variables that are different from approaches used by those in the marketing-relationalism area.

Second, this research can provide useful information for those organizations that have not been successful in their upstream management.

- This research has identified the most and least frequently used tools/joint practices. By using this information, organizations, especially those trying to establish a partnership (less *mature* with respect to partnerships), can avoid selecting tools/joint practices that have not been generally used in a similar business environment.

- This research also provides information about tools/joint practices that are perceived effective and are internalized by other organizations. By using this information, organizations may be able to select more effective and internalized tools/joint practices.

- This research has also examined perceived improvements in three organizational performance dimensions (quality, cost, and cycle time) and has identified tools/joint practices that have been used to improve each of the three performance dimensions. Because each organization has different goals and objectives at different points in time in terms of improving quality or reducing cost and cycle time, the information derived can be used by different organizations that have different interests in improving each of the three performance dimensions.

However, it should be noted that tools/joint practices other than those identified in this research as the most frequently used and the most effective and internalized, such as

QFD and benchmarking, may be appropriate and effective tools/joint practices for organizations, especially those that have already established a mature partnership with customers or suppliers.

Third, this research will also benefit those organizations that have been successful in their upstream management.

- First, through the use of the information provided above, this research will provide additional opportunities for organizations to re-evaluate the overall effectiveness of their upstream systems in order to further improve. This can be done by comparing their upstream management practices in terms of the frequency of use, effectiveness, and internalization of each tool and joint practice with other organizations' practices that can be generally accepted by SIC 35, 36, and 37 business environments.

- Second, this research suggests a model, presented in the following chapter, of how to use tools/joint practices in an integrated way, and identifies tools/joint practices which can be used in future q1-q3 relationships. By comparing this model to current practices, organizations will be able to identify gaps, if any, between their practices and prescribed tools/joint practices based on these findings.

5.12   *Limitations of This Research*

Five limitations of this research are discussed in this section. These limitations should be considered in attempting to generalize findings of this research outside of this study. These limitations also form the basis for possible future research directions (discussed in the following section).

First, the design of research used – non-experimental – limits the ability to draw causal inferences (i.e., increased TQMT caused increased or decreased INFPRT). This research has provided evidence of relationships between independent and dependent variables, but not evidence of cause-and-effect relationships.

Second, the findings and conclusions drawn from this research should be viewed in the light of the research focus used. Although the answers to the four research questions that include hypothesis testing yield several results that are consistent with other studies (see Section 5.8), the fact that a partnership between q1 and q3

organizations was used limits the ability to rule out alternative causal inferences on general q1-q3 relationships. Because a partnership implies that several key factors, such as two-way communication, specific investments, and trust, exist between two parties as pre-requisite conditions, alternative causal inferences can be found in non-partner type q1-q3 relationship in which more business transaction-oriented factors govern the two parties' relationship.

Third, only four dimensions of the shared results of using tools/joint practices were used in this research as a set of dependent variables. However, it is possible that other dimensions need to be included in the set of dependent variables, depending on the specific business environment of q1-q3 relationships. One extension of this research's conceptual and operational framework would be to include such situation-dependent shared results dimensions in the model that can be found in other studies. Examples are solidity and restraint (Kaufmann & Dant, 1992), dependence of customer on supplier (Ganesan, 1994), and cultural similarity and goal congruence (Anderson & Weitz, 1989).

Fourth, although the results and findings in this research are encouraging for scales which were based on a theoretical framework in relationalism, a great deal of further research remains to be done. One area of survey limitation relates to the list of tools/joint practices provided in Item #45. For example, *gainsharing* should not be included in the example list of survey questionnaire Item # 45 without appropriate modifications in future research. This is because the term gainsharing implies dividing financial gains between individuals or departments within the same organization, not between two organizations. The term *sharing financial benefits/cost savings*, for example, would be more appropriate. Another example relates to *quality circles*. In most cases, quality circles have been used in the form of either cross- or within-functional teams, not in the form of cross- or inter-organizational teams. The term *cross- or inter-organizational teams or task force* would be more appropriate. These kinds of modifications can be made in future research.

Fifth, the research sample – q1-q3 relationships in SIC 35, 36, and 37 private manufacturing companies – presents another limitation of this research, in that caution

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must be exercised in generalizing findings to organizations with different characteristics (e.g., service industries).

5.13   *Areas for Future Research*

This section proposes several future research directions that will further expand the body of knowledge on upstream management and that have not been addressed in this research.

First, although this research has proposed a set of practices as a means to improve q1-q3 relationships, the proposed practices have not been proven useful or effective in the way they are portrayed in the following chapter. In this context, one of the future research directions could be formative evaluation of q1-q3 relationships in which the practices proposed in Section 6.1 have been used. By gathering data on performance results from the companies using these practices, formative evaluation research will allow a researcher to evaluate the strengths and weaknesses of each practice and even the upstream systems in which the practices have been used. This can be done by comparing *what is* (findings from the target company or q1-q3 relationship) with *what should be* (theoretical assertions on benefits from using each practice). In this way, the validity of suggestions and recommendation made in previous sections can also be evaluated.

In Section 6.1, the practices have been proposed to be used in an integrated way, and not to be used independently from other practices. In this context, a second future research direction would be to compare those q1-q3 relationships (and their performance, including improvements in specific organizational performance dimensions and their practice of results sharing) that have used at least most of the proposed practices with others that have not used the proposed practices in an integrated way. Subject q1-q3 relationships for this suggested research can be found in both large and small companies. For example, it is very likely that many large companies, whether they are customer or supplier organizations, have used most proposed practices in their relationships with partners because of the scope and size of their businesses. On the other hand, it was found in this research that many small companies, especially small suppliers, tend to use fewer practices than large companies. Future research can investigate which way of

using the proposed practices – an integrated way or separately – is more effective by doing the following. Future research could compare the performance of JIT delivery/production, for example, of large companies' which is likely to be a combined result from using other practices such as EDI and supplier certification/verification, with the performance of small companies' where JIT delivery/production is the only joint action.

Third, to examine whether or not the proposed practices have made significant contributions to the successful q1-q3 operations of excellent companies such as Xerox, GM, and Motorola, the overall effectiveness of proposed practices needs to be examined in q1-q3 relationships that have already proven successful. By doing this, the following three things can be determined.

- The intensity of the use of proposed practices by excellent companies can be identified in terms of the number of practices used and the levels of effectiveness and internalization.
- If those companies have used the proposed practices intensively, it can also be determined whether or not the same set of practices can be applied to other similar q1-q3 environments, based on those exemplary companies' experiences.
- If companies have not intensively used the proposed practices, other practices can be identified that contribute to successful q1-q3 operations.

Fourth, one of the issues this research did not address was which practices have been used to improve the degrees of four shared results dimensions. To address this point, either formative evaluation research or case studies can be conducted on q1-q3 relationships in which the hypothesized relationships between independent and dependent variables are supported from both perspectives. Identifying specific practices that will improve the degree of each of the four shared results dimensions will greatly help other q1-q3 relationships or organizations select the right practices based on their current result-sharing practices.

Fifth, this research could not explain why customer and supplier organizations had different perceptions of the relationship between q1-q3 joint action and conflict

resolution (CR). To explain differences in this perception, pairs of customers-suppliers and their opinions and experiences need to be analyzed with respect to this specific shared result dimension. Only from an in-depth analysis of how pairs of customers and suppliers manage this shared result dimension can differences be explained.

Sixth, future research could improve the reliability and validity of the scales. Although Cronbach's alpha values were considered acceptable for newly developed scales, Nunnally (1978) suggests that frequently-used scales should have a minimum alpha value of 0.80. This can be accomplished by continuing to add and modify items, based on feedback obtained by testing the scales in various samples. It is important to test these scales using samples from other populations in order to enhance their generalizability.

5.14   *Overview of This Research*

This research on q1-q3 relationship was conducted from the Management Systems Engineering perspective with a design emphasis: how to design, develop, and use tools/joint practices. To do this, major constructs − independent and dependent variables − were adopted from the discipline of marketing-relationalism. The mailed survey questionnaire, focus group interview guide, and structured interview guide were developed to collect the quantitative and qualitative data that were used to answer the four research questions. To collect data, 1, 811 managers in buying, selling, quality-related, and operations/production functions of U.S. private manufacturing companies in SIC 35, 36, and 37 industries, and 7 managers of the same functions from the previous SPQA winners, and NAPM and ASQ Roanoke-Radford section were used. Using the total 172 survey responses and structured interview data, the four research questions were answered from the three perspectives − customer, supplier, and overall − using the data analysis methods described in Chapter 3, and results and findings were presented in Chapter 4. In this chapter, conclusions were drawn regarding q1-q3 relationships, based on results and findings.

In the following chapter, practical implications are made based on the key results and findings from this research that will help organizations further improve their q1-q3 relationships.

CHAPTER 6. PRACTICAL IMPLICATIONS

The purpose of this chapter is to identify practical implications (suggestions, recommendations, and applications) from the findings and conclusions presented in preceding chapters.

Although findings from this research are based on a relatively large sample size (172 survey respondents and 7 interviewees), it should be noted that recommendations made in this chapter should be considered carefully by other organizations, especially those companies that are not in SIC 35, 36, and 37 categories. One of the reasons this research used managers of buying, selling, quality-, and operation- or production-related functions of SIC 35, 36, and 37 companies was that those companies are more likely to establish partnerships due to the nature of their business. In other words, parts and components, or even final products manufactured by SIC 35, 36, and 37 companies are more frequently transacted between q1 and q3 companies. Therefore, implications in this chapter as well as findings from previous chapters should not necessarily be applied to companies whose major products are different from those of the sampled organizations' without modifications due to the different business environments.

6.1   *Proposed Use of Practices*

This section proposes a model of how and/or why the tools/joint practices identified in this research should be used. These practical implications are based on empirical findings presented in Chapter 4 and discussed in Chapter 5, but also on the literature. In this sense, this chapter represents a merging of prescription based on the findings from this research and findings and recommendations in the literature.

Figure 6-1 shows the prescriptive model and the following sections explain each practice and how it can be used. Figure 6-1 consists only of practices that have been identified as the most frequently used and have been the most effective and/or

internalized (from the mailed survey questionnaire) and others (from the structured
interview) that will benefit q1-q3 relationships in an integrated way.
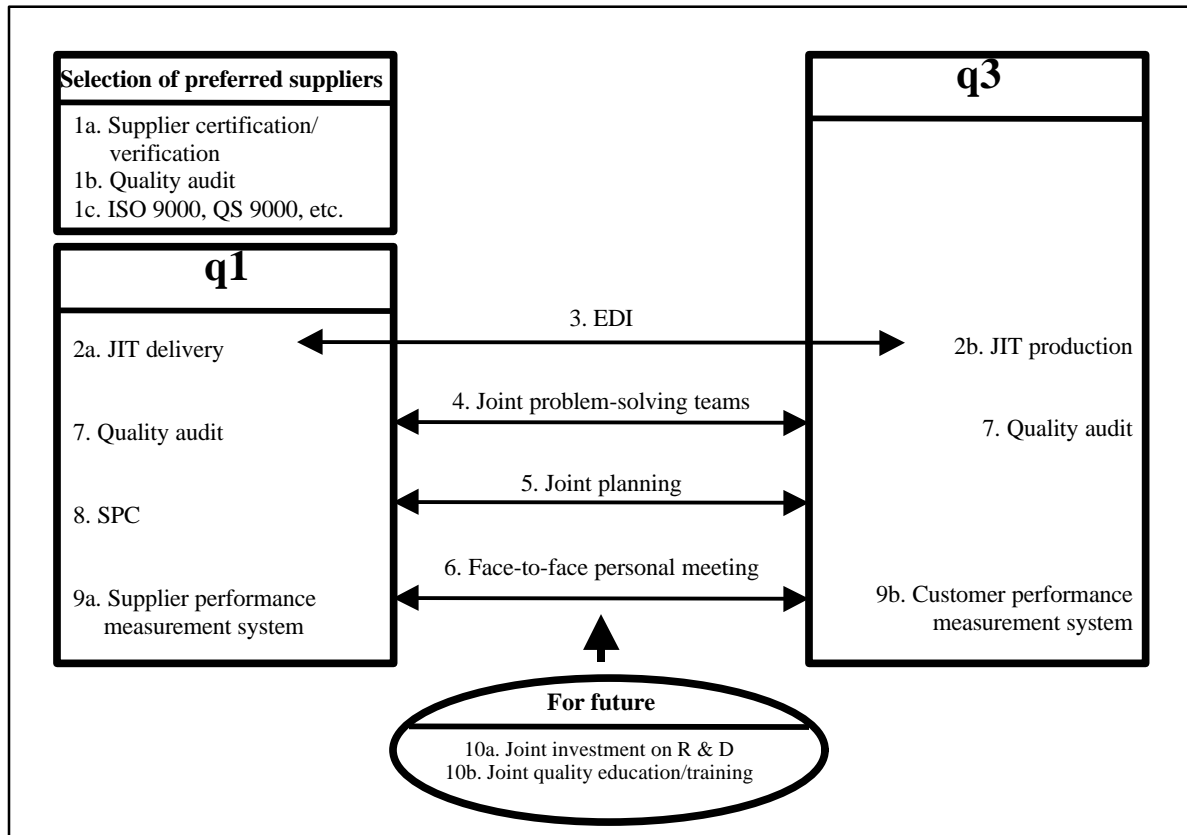
Figure 6-1. Model of Customer-Supplier Joint Practices

6.1.1   Selection of preferred supplier(s)

One thing a customer needs before establishing a partnership with the supplier is
supplier certification or verification. This is because a partnership is based on many
critical factors, such as good two-way communication, a long-term view, a mentality for
total cost reduction, etc., as was identified in the mailed survey questionnaire (first item
of Part I). Other factors also defined by interviewees as important partnership
components were:

- *"supplier's better understanding of the customer's ultimate goals (business success),"*
   (1041)

- *"joint venture and research for new products and alternative material development,"* (2041) and,
- *"willingness to share technology development."* (4042)

These factors or components are not easily obtained without establishing partnerships with preferred suppliers. In this context, supplier certification/verification (1a) is proposed as a practice for selecting preferred suppliers.

Many other tools/joint practices can be used to certify or verify suppliers. One of the tools/joint practices most frequently used as well as the most effective and internalized as identified in this research is quality audits (1b). External quality audits are recommended in initial supplier certification. This is because the customer can objectively measure and evaluate the supplier's business practices, including the current overall level of quality systems, by hiring external auditors. In this way, the customer can be sure that the supplier has enough capacity to meet its requirement and needs.

What quality standards or criteria should be used in the quality audit? Although many standards and criteria are available, a set of standards and criteria – ISO 9000 and/or QS 9000 and/or Baldrige Award criteria – has been identified as most effective and internalized in this research. Because all findings in this research were based on responses from SIC 35, 36, and 37 companies, and because companies in the same or similar industry groups are major targets of the practical implications revealed by this research, ISO 9000 and/or QS 9000 and/or Baldrige Award criteria is one logical choice for U.S. private manufacturing companies in SIC 35, 36, and 37 categories. For example, SIC 37 (transportation equipment) companies and other related business owners can use either ISO 9000 or QS 9000 standards, or both. This is because ISO 9000 is a conceptual documentation of how to do quality program and quality system which allows companies to determine the most effective way of implementing and deploying the stated requirements that may vary among companies (Lamprecht, 1992), and because QS 9000 was developed by the big three U.S. auto makers specifically for their suppliers (Struebing, 1996). On the other hand, SIC 35, 36 and other small business owners, especially small suppliers, can use not only ISO 9000 standards but also Baldrige Award

criteria because two out of three Baldrige Award competition categories are manufacturing companies and small businesses (NIST, 1996) and because ISO 9000 standards and Baldrige Award criteria are widely applicable.

In summary, a set of three practices is recommended to be used in the preferred supplier selection phase: supplier certification/verification, quality audit, and ISO 9000 and/or QS 9000 and/or Baldrige Award criteria.

6.1.2   Practices after preferred supplier selection

Once the partnership is established between q1 and q3 organizations after selecting preferred suppliers, it is necessary for the two companies to stabilize and improve their relationships in both business and non-business aspects. This section describes practices that can be used to achieve that purpose.

First, JIT delivery/production (2a & 2b) is recommended because this practice was identified as one of the most frequently used, the most effective, and the most internalized. In addition to the benefits gained from using JIT delivery/production that were mentioned in Chapter 5, both companies can take advantage of JIT delivery/ production. For example, more communication and information exchange through EDI help suppliers have more discretion in their customers' product and process design, and manufacturing methods. If suppliers understand customers' production processes, it will be easier for them to meet customer requirements. Also one of the major characteristics of JIT delivery/production is production of small lot sizes and frequent deliveries. Producing small lots means the supplier needs to have a flexible manufacturing system to reduce inventory and scrap levels and increase the quality of their products. Frequent delivery of small lots reduces the customer's and the supplier's inventory level and associated cost.

To benefit from JIT delivery/production, the two companies must do some pre-work for systematic JIT practices: e.g., supplier certification/verification (already discussed earlier) and Electronic Data Interchange (EDI). Supplier certification/ verification and more frequent contacts result in open information sharing between the two companies, regarding product design, process modification, purchase orders, and

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other business transactions. This exchange of information can be improved by EDI (3).
This is why EDI is selected as one of the proposed practices. (EDI was identified three
times by 40 mailed survey respondents as one of additional tools/joint practices in survey
Item # 46.)

In combination, JIT delivery/production and EDI can also produce many
intangible, but unique advantages. These include reduced lead time or cycle time, on-
time delivery, better material availability, reduction in paperwork or even paperless
operations, better production scheduling, and long-term relationships between the two
companies, partially because of specific investment made by both on EDI.

Two other proposed practices are joint problem-solving teams (4) and joint
planning (5). These two have been selected because they were two of the most frequently
used, most effective, and most internalized tools/joint practices. As mentioned in
Chapter 5, joint problem-solving teams can be used for many different purposes in many
different formats on an ongoing basis to review failed operations or systems, and to take
and document corrective actions. On the other hand, the supplier can be involved in early
stages of design, test, and manufacturing to jointly plan new products with the customer.

The next practice proposed in this research is face-to-face personal meetings (6).
It has been selected because face-to-face personal meeting was also one of tools/joint
practices identified by the survey respondents three times in survey Item # 46. (See
Table 6-1 for more information about which proposed practices were identified as the
most frequently used and/or the most effective and/or the most internalized and for how
many interviewees mentioned which additional tools/joint practices.) Other tools/joint
practices identified by interviewees that are similar to face-to-face personal meetings are:

- *"good hand-shaking," (5111) and*
- *"good personal relationships." (4222)*

The roles and importance of personal meetings cannot be emphasized enough because
q1-q3 relationships involve not only business-related transactions but also frequent
interpersonal interactions. Personal meetings, as well as good hand-shaking and good
personal relationships, can not only help suppliers understand their customers' business

better, but both parties can implement new tools/joint practices and technologies because of their honest and trusting personal relationships.

Table 6-1. Proposed Practices

Tools/Joint practices	One of most frequently used?	One of most effectively used?	One of most internalized?
1a. Supplier certification/verification	Yes	No	No
1b. & 7. Quality audit	Yes	Yes	Yes
1c. ISO 9000 and/or QS 9000 and/or Baldrige Award	No	Yes	Yes
2a & 2b. JIT delivery/ production	Yes	Yes	Yes
3. EDI	Identified three times by interviewees and 40 survey respondents		
4. Joint problem-solving teams	Yes	Yes	Yes
5. Joint planning	Yes	Yes	No
6. Fact-to-face meeting	Identified three times by interviewees and 40 survey respondents		
8. SPC	Yes	No	No
9a & 9b. Supplier or customer performance measurement system	No	No	Yes
10a. Joint investment on R & D	No	No	No
10b. Joint quality education/training	No	No	No

The next proposed practice is either internal quality audit (7a) or external quality audit (7b), or both. Because the external quality audit was used in a preferred supplier selection phase, the purpose of the quality audit used in this phase is different. One of the purposes can be to re-certify suppliers and their capability to continuously meet the customer's requirements and needs. Frequency of re-certification can vary among organizations, depending on product life-cycle, number of current suppliers, and other unique q1-q3 situations. The selection of either internal or external audits also depends on several factors. For example, the external audit may be desirable if parts and components supplied by suppliers are critical to the customer's production process or the quality of final products. Otherwise, the internal audit can be used.

Although SPC (8) was not perceived as being more effective and internalized than other practices in Figure 6-1, it is proposed in this research as a practice that can be used by suppliers. This is because two out of six interviewees who took the customer perspective indicated that more use of SPC by suppliers would be one of the specific

trends in future q1-q3 relationships. Also supplier and customer performance
measurement systems (9a & 9b) were included in Figure 6-1 although they were not the
most frequently used nor perceived effective. However, performance measurement
systems were identified as one of the most internalized tools/joint practices both by the
customer and the supplier.

The practices proposed so far have been demonstrated useful by many companies.
However, some of these practices, such as SPC and supplier certification/verification,
were not perceived as effective and internalized by participants in the mailed survey
questionnaire. One of the reasons for this can be found in three interviewees' answers to
interview question # 13 (If you have experienced roadblocks/barriers in using tools and
joint practices in the relationship with your partner, what are they?).

> *"Suppliers don't want to change their business, operations, and processes," (1131)*
> *"Suppliers don't understand their customers' business initiatives and importance,"*
> *(1131) and*
> *"Because many suppliers are relatively small, it is unlikely that they use as many tools*
> *and joint practices as we do. This is partially because they do not want to hire external*
> *consultant(s) to implement tools and joint practices. In addition, they don't want to*
> *change their business practices, operations, and processes just for us because they have*
> *other customers and orders from those customers." (6131).*

One important implication for the customer can be found in the interview data that is
related to the next set of proposed practices. Because of suppliers' relatively small
organizational size and their tendency to rely on long-term relationships with multiple
source partners, it is expected that suppliers do not usually initiate changes in their
business practices and resist using tools and joint practices. If this is the case, what can
customers do to encourage suppliers to use more practices that are proposed in this
research?

A set of two practices is proposed in this research: joint investment on R & D
(10a) and joint quality education/training (10b). These two practices are proposed, even
though neither one of them was used frequently nor perceived as effective and
internalized, because of the following two reasons. First, one of the strong future trends

in q1-q3 relationships identified by interviewees was different types of joint R & D activities, such as:

- *"joint evaluation of alternative materials (to develop total cost-effective production systems)," (2201)*
- *"joint technology development," (4202) and*
- *"joint market analysis." (5201)*

Second, in order for the supplier to be involved in joint R & D activities, they need to have a higher level of appreciation for quality both in general and in their specific relationship with partners – their customers.

However, as mentioned earlier, because of suppliers' relatively small organizational size, the customer needs to invest more resources in joint R & D and quality education/training programs. More investment in joint R & D and quality programs from the customer means that they can solidify the relationship with their suppliers, which, in turn, will encourage suppliers to maintain long-term relationships with the specific customer who has made an investment. As a result, customers want to build and maintain partnerships with suppliers because of their specific investments. Also, because of specific investments made by customers in joint quality education/training programs, suppliers will be able to use more practices, SPC for example, and will have a better appreciation for quality, which will help suppliers play a major role in joint R & D activities.

6.2 Relationship Between Proposed Practices And Organizational Performance

Other than the benefits gained from using the set of practices mentioned in Section 6.1, the customer and supplier organizations could take advantage of using the proposed practices in the future. For example, they could be more willing to share technology development and allocate part of each of their development resources to make innovative efforts. Also the supplier will be able to guarantee the best price, products, and quality that would make the customer competitive.

Then, do the proposed practices contribute to the improvement of specific organizational performance? Results were presented in Chapter 4 and Table 6-2

(reproduction of Table 4-36) shows the perceived contribution by managers that the proposed practices have made in three organizational performance dimensions in terms of frequency of use.

Table 6-2. Tools/Joint Practices Used to Improve Quality, Cost, and Cycle Time (Reproduced)

C: Customer   S: Supplier   O: Overall

Tools/joint practices	Quality			Cost			Cycle time		
	C	S	O	C	S	O	C	S	O
	(67)	(54)	(121)	(59)	(48)	(107)	(50)	(42)	(92)
1: Benchmarking	8	6	14	8	3	11	5	6	11
2: Cost of quality	2	6	8	7	9	16	0	1	1
3: Gainsharing	1	1	2	7	4	11	1	0	1
4: JIT production/delivery	6	4	10	21	11	32	27	17	44
5: Quality circles	1	4	5	0	2	2	0	1	1
6: Quality Function Deployment	0	10	10	2	2	4	0	0	0
7: Statistical process control	21	21	42	6	12	18	3	6	7
8: Supplier certification/verification	14	12	26	4	8	12	4	3	9
9: Joint quality education/training	7	6	13	5	2	7	1	3	4
10: Joint problem-solving teams	28	14	42	15	13	28	10	6	16
11: Joint planning	4	8	12	14	13	27	18	14	32
12: Exchange of strategic information	9	6	15	19	9	28	12	6	18
13: Quality audit	25	15	40	7	9	16	2	3	5
14: Joint investment on R&D	0	5	5	3	5	8	1	4	5
15: In-plant representative	6	6	12	4	3	7	6	1	7
16: Supplier or customer performance measurement system	21	12	33	8	6	14	5	1	6
17: ISO 9000 and/or QS 9000 and/or Baldrige Award criteria	13	15	28	6	5	11	7	0	7
18: Dynamic control tools (e.g., flow diagram, FMEA)	10	8	18	4	4	8	2	1	3
Total (Average)	176 (2.63)	159 (2.94)	335 (2.77)	140 (2.37)	120 (2.50)	260 (2.43)	104 (2.08)	73 (1.74)	177 (1.92)

In general, the proposed practices, which are shaded in Table 6-2, have been used more frequently than have other tools/joint practices. However, this research did not address which practices have been or should be used to improve results-sharing practices between two organizations. Instead, potential benefits from using the proposed practices can be derived in terms of what practices will affect better results-sharing, based on the

nature of each proposed practice. For example, by using more EDI and JIT delivery/ production, two organizations will be able to share more strategic and operational information and provide suggestions to each other that will improve quality and productivity (INFPRT). By engaging in different joint activities that have different purposes via joint problem-solving teams and joint planning, the two organizations will be able to increase the degree of role integrity (RI). More informal and frequent face-to-face meetings will help the two organizations resolve conflicts less formally (CR). Also more joint investment on R & D and joint quality education/training and continuous quality audits will provide the two organizations with different ways of sharing the benefits of their relationships fairly, including cost savings (MU).

6.3   *Proposed Practices and Baldrige Award Criteria*

The purpose of this section is to demonstrate support or evidence of how the proposed practices can be used to help organizations in becoming world-class companies. This is done by comparing each proposed practice in this research with two Baldrige Award criteria – Management of Supplier and Partnering Processes (6.3) and Supplier and Partner Results (7.4). In making this comparison, the assumption is that because these two items are included in the Baldrige Award criteria, they are considered by experts to be an important component of a quality improvement/management system. Table 6-3 provides definition of these two criteria and sample effective practices for each criterion defined by Blazey (1997).

For example, customers' requirements are clearly defined in both suppliers' and customers' performance measurement systems and can be communicated to suppliers through quality audit or face-to-face meetings (see the first item). Also, joint problem-solving teams can propose necessary actions to reduce unnecessary costs by improving the internal performance systems of suppliers using practices such as JIT delivery/ production (see the seventh item). All items in *Supplier and Partner Results (7.4)* can be achieved by two organizations' commitment to building and managing well-designed performance measurement systems. (Practices in Table 6-3 are not exhaustive. Depending on the specific q1-q3 relationship, many other practices could be added.)

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Table 6-3. Baldrige Sample Effective Practices and Proposed Practices

Baldrige Award criteria and sample effective practices	Suggested tools/joint practices
Management of Supplier and Partnering Processes (6.3) Baldrige Award criteria (NIST, 1996) - How supplier and partnering processes are designed to meet overall performance requirements, - How the company ensures that these requirements are met, and - How the company evaluates and improves its management of supplier and partnering processes to achieve better performance. Sample effective practices (Blazey, 1997) • Performance requirements are clearly defined in measurable terms and communicated to suppliers. • Decisions on which suppliers to use are driven by measurable performance characteristics of the supplier, rather than primarily on price. • Measures of expected supplier performance are in place. • Data on supplier and partner performance are provided to suppliers frequently so that they can adjust and improve performance. • The organization has a system in place to review and improve its own procurement processes and processes for communicating with and selecting suppliers and partners. • Procedures are in place to improve supplier and partner performance (for example, fewer defective parts, less rework and scrap, faster response time) that include training or certification programs. • Actions are taken to reduce unnecessary costs, such as incoming inspection or testing, by improving the internal performance systems of suppliers and partners.	 • Supplier and customer performance measurement systems, quality audit, face-to-face meetings • Supplier certification/verification, quality audit • Supplier performance measurement system • EDI, face-to-face meeting, joint planning • Supplier certification/verification, Quality audit, EDI • Supplier performance measurement system • Joint problem-solving teams, JIT delivery/ production
Supplier and Partner Results (7.4) Baldrige Award criteria (NIST, 1996) - Summarize current levels and trends in key measures and/or indicators of supplier and partner performance. Sample effective practices (Blazey, 1997) • Results are broken down by key suppliers or supplier types as appropriate. Data are presented using the measures and indicators of supplier performance • If the organization's supplier management efforts includes factors such as building supplier partnerships or reducing the number of suppliers, data related to these efforts are included in responses. • Supplier performance measures include defect rate, on-time delivery, and number of certified suppliers. • Indices and trend data are provided in graph and chart form. Multiyear data are provided. • All results show steady improvement. • Graphs and information are clear and easy to understand. • Data are not missing: all data declared to be important are reported. • Comparison data for suppliers of benchmark or competitor organizations are reported. • Data are broken down by meaningful supplier categories to demonstrate consistent improvement in easy categories.	 Supplier and customer performance measurement systems

It appears from Table 6-3 that Baldrige Award criteria have more focus on specific performance measures in managing supplier and partnering processes than this research showed. (In this research, supplier performance measurement system is one of

proposed practices. It is beyond the scope of this research to elaborate each proposed practice in terms of how to use it.)

6.4   *Summary of Practical Implications*

This chapter has proposed a set of practices as a means to improve q1-q3 relationships, based on the results and findings from this research. A set of three practices was first proposed to be used in preferred supplier selection phase. These were (1a) supplier certification/verification, (1b) quality audit, and (1c) ISO 9000 and/or QS 9000 and/or Baldrige Award criteria. Next, a set of 10 practices was proposed to further improve q1-q3 relationships after selecting preferred suppliers. These were (2a & b) JIT delivery/production, (3) EDI, (4) joint problem-solving teams, (5) joint planning, (6) face-to-face personal meetings, (7) quality audit, (8) SPC, (9) supplier and/or customer performance measurement system, (10a) joint investment on R & D, and (10b) joint quality education/training.

Because these practices were selected based on the empirical findings from this research and recommendations from the literature, managers can utilize these practices and achieve benefits once they understand characteristics of each practice. To develop a better understanding of each practice, including how to use it and what benefits can be realized, managers may need to study case examples that can be found in many practitioner-oriented and empirically-grounded literature. Table 6-4 provides some sources of examples that will help managers better understand each proposed practice in terms of how and what to do in order to use it.

To develop a successful partnership, managers also need organizational support, especially from top management. This is because systematic planning and different types of investments are two key success factors to an improved q1-q3 relationship. For example, to be successful in JIT delivery/production, two organizations need a detailed blueprint of how to use this practice. The blueprint may include how to select and certify suppliers, which quality standard should be used to certify/verify suppliers and their performance, and how and when EDI should be in place, etc. Also, to be successful in implementing the plans, two organizations may need to make different types of

investments such as purchasing new equipment (e.g., computers and other network systems for EDI), employee training/education on quality audit, and certification and re-certification costs.

Table 6-4. Examples of How & What-to-do for Each Proposed Practice

Proposed practices		Sources of example practices[*]
(1a)	Supplier certification/verification	Ellram (1990), Morgan & Zimmerman (1990), and Thompson (1990)
(1b, 7)	Quality Audit	Corrigan (1994), Freese & Konold (1994), Hockman et al. (1994), and Sakofsky & Vitale (1994)
(1c)	ISO 9000 and QS 9000 and/or Baldrige Award	Bemowski & Stratton (1995), Corrigan (1994), Freese & Konold (1994), Garvin (1991), Hockman et al. (1994), Reimann (1989), and Sakofsky & Vitale (1994)
(2a, 2b)	JIT delivery/production	Billesbach et al. (1991), Cross (1995), Giunipero (1990), Radovilsky et al. (1996), Raia (1990), and Schonberger & Ansari (1984),
(3)	EDI	Giunipero (1990)
(4)	Joint problem-solving teams	Chen & Batson (1996) and Stuart & Muller (1984)
(5)	Joint planning	Johnson (1989) and Johnson & Lawrence (1995),
(6)	Face-to-face meeting	
(8)	Statistical process control	Burr (1990), Juran Institute (1990), Sarazen (1990),and Shainin (1990),
(9a, 9b)	Supplier or customer performance measurement system	Billesbach et al. (1991), Brown (1996), Cross (1995), Fortuna (1988), Johnson (1989), and Morgan & Zimmerman (1990),
(10a)	Joint investment on R & D	Landeros &Monczka (1989)
(10b)	Joint quality education/ training	Cayer (1990) and Morgan & Zimmerman (1990)

*: References used in this table include only articles and papers published in practical journals and conference proceedings. A full list of references can be found in *References* section of this document.

Although it is beyond the scope of this research to provide specifics about how to induce top management's support, this research has provided the following: suggestions/recommendations about which practices may be used (Chapter 6), when

these practices can be used – before and after preferred supplier selection phase (Chapter 6), and basic, but important, characteristics of each practice in various parts of this document as well as in-depth answers to the four research questions (Chapter 4) and conclusion from the results (Chapter 5).

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APPENDIX A. JOINT ACTION FOR UPSTREAM MANAGEMENT

The purpose of this Appendix is to describe the tools/joint practices that are used in upstream management as a means to achieve better customer-supplier relationships. Some of the exemplary tools/joint practices used to produce better q1-q3 partnerships are introduced in two groups – tools/joint practices used to build desirable q1-q3 relationships, and tools/joint practices used to improve the performance of upstream management.

It is reasonable to consider the TQM perspective as a type of comprehensive quality management that leads to efforts towards improvement. These efforts can be divided into two categories. The first is a quality program that emphasizes the suitability of the documentation of organizational quality activities. Briefly, the quality program is a suitability or in-depth comparison and evaluation of the documentation of products, processes, services, etc. with reference to an agreed upon, predetermined reference standard (Mills, 1989). A quality program includes the policies, procedures, operating instructions, etc. that define the various responsibilities, accountabilities, and actions necessary to achieve the desired quality level. The quality level is based on:

- the desires of management,
- the needs of the intended marketplace,
- national or international standards for quality assurance,
- procurement quality standards from major customers and potential customers,
- good manufacturing practices as laid down by certain regulatory agencies,
- specific requirements in the applicable product, service, or process specification or standard.

The second quality management and improvement effort is a quality system that emphasizes the conformity of the company's operations to the quality program (Mills, 1989). This is an in-depth examination of the quality system to determine the effectiveness and compliance of the system with the predetermined reference standard. The quality system can cover one or all of the following categories:

- performing a suitability quality audit on the quality program with respect to some predetermined quality system requirement; then, if the documentation is satisfactory, performing a conformity quality audit to determine the effectiveness of the resulting activities.
- performing a suitability audit on the changes made to an approved quality program to confirm that it is still acceptable; if it is still suitable, performing a conformity quality audit to evaluate the changes and determine continuing compliance with the approved quality program.
- performing repetitive or periodic conformity quality audits on the implementation of an approved quality program to determine continuing compliance and effectiveness.

Then, based on these two proposed general quality interventions, the important question to ask and answer is "How do we know we have quality programs and systems appropriate for our business operation?" This question may be partially answered by the use of specific tools/joint practices that are introduced later in this Appendix.

The two most prestigious and robust quality-related tools/joint practices are said to be ISO 9000 standards and the Malcolm Baldrige National Quality Award (MBNQA). They are well-known rewards; being registered as an ISO 9000 organization or winning a MBNQA means that the company has established an appropriate quality program for its operation, and its operation conforms to that quality program.

Many books, articles, and papers discuss the positive and negative aspects of these two quality standards and criteria. Below is a condensed description of these two widely used quality guidelines.

ISO 9000

ISO 9000 is a series of five international standards for quality management. It provides concepts and definitions that cover various aspects of a quality assurance program using the following five emphases (emphases of each of the series are italicized):

- ISO 9000: Road map to the other quality standards in the series; key definitions and principal concepts; the use of quality standards for contractual purposes; assistance in selecting the appropriate standard
- ISO 9001: Quality system model for a contract requiring supplier capability to design *and develop, produce, inspect, test, train, install, and service*

- ISO 9002: Quality system model for a contract requiring supplier capability to *produce*, *inspect, test*, *train*, and *install*
- ISO 9003: Quality system model for a contract requiring supplier capability to *inspect*, *test*, and *train*
- ISO 9004: Services organization standard, including policies and objectives, system management, human resources, and documentation
(Source: Mahoney & Thor, 1994; Rabbitt & Bergh, 1994)

As shown, there is some overlap among emphasizes in the series. Therefore it is important to select the right standard that fits the organization's operation. Many people think that ISO 9001 is the most powerful standard, a belief criticized by experts.

What aspect of organizational operations does the ISO 9000 series standard cover? There are many sources of ISO 9000 related materials. The following summary is one of them, which explains the coverage of each standard in more detail.

Table A-1. ISO 9001, 9002, and 9003 Coverage
(Source: Arnold, 1994)

9001	9002	9003	Coverage
x	x		Management responsibility
x	x	x	Quality system
x	x		Contract review
x			Design control
x	x	x	Document control
x	x		Purchasing
x	x		Purchaser-supplier product
x	x	x	Product identification traceability
x	x		Process control
x	x	x	Inspection and testing
x	x	x	Inspection, measuring, and test equipment
x	x	x	Inspection and test status
x	x	x	Control of nonconforming products
x	x		Corrective action
x	x	x	Handling, storage, packing, and delivery
x	x	x	Quality records
x	x		Internal quality audit
x	x	x	Training
x			Servicing
x	x	x	Statistical techniques

The ISO 9000 is not industry specific; it is a general guideline for good, efficient business operation. Unlike most other quality criteria, the ISO 9000 series standard is a conceptual documentation of how to do a quality program and a quality system. In other words, the ISO 9000 allows the organization to determine the most effective way of implementing and deploying the stated requirements, which vary among organizations. It provides direction while allowing each company creativity in determining how best to implement the standard.

The ISO 9000 standard can be used for the purpose of a company's internal quality assurance and to focus on the relationships between the company and its suppliers. For example, some items, such as purchasing and purchaser-supplier products, directly relate to the relationships and actual transactions between a company and its suppliers.

Compared to the MBNQA, which will be briefly introduced in the following section, the ISO 9000 focuses on the ability to achieve standards negotiated in a documented contract. Other quality criteria found in the MBNQA, as well as others, focus on continuous improvement toward achievement of world-class quality levels.

Malcolm Baldrige National Quality Award (MBNQA)

The MBNQA was established in 1987, by Public Law 100-107, to improve quality and productivity by:

- helping to stimulate American companies to improve quality and productivity for the pride of recognition while obtaining a competitive edge through increased profit;
- recognizing the achievements of those companies that improve the quality of their goods and services and providing an example to others;
- establishing guidelines and criteria that can be used by business, industry, government, and other organizations in evaluating their own quality improvement efforts; and
- providing specific guidance for other American organizations that wish to learn how to manage for high quality by making available detailed information on how winning organizations were able to change their cultures and achieve eminence (NIST, 1989).

The MBNQA continues to evolve since it was established (Stratton, 1990; Riemann, 1992; NIST, 1994a). The award criteria are reviewed and revised each year, but their basic purpose remains consistent with Public Law 100-107. The recent (1996)

award criteria comprise seven categories built upon the following core values and concepts: customer-driven quality, leadership, continuous improvement and learning, employee participation and development, fast response, design quality and prevention, long-range view of the future, management by fact, partnership development, corporate responsibility and citizenship, and result orientation.

Applicants are judged according to seven criteria categories – 1.0 Leadership, 2.0 Strategic planning, 3.0 Customer and market focus, 4.0 Information and analysis, 5.0. Human resource development and management, 6.0 Process management, and 7.0 Business results (1996). This includes twenty Sub-Criteria Categories, and seventy-three specific Areas to Address as currently constructed.

Having been identified as one of the two most powerful quality guidelines, the MBNQA, unlike the ISO 9000 series standard, places the greatest emphasis on customer satisfaction. There are few mandatory techniques, but winning essentially requires a substantial prevention orientation. Based on this brief introduction of ISO 9000 and MBNQA, it is recommended that the organization first consider ISO 9000 as a stepping stone to achieve minimum required quality levels, and then to use the MBNQA criteria to achieve a world-class quality.

A.1 Specific tools/joint practices for upstream management

In this section, the Management Systems Engineering (MgtSE) body of knowledge on upstream management is considered. A literature review explores current tools/joint practices widely used and discussed by many academicians and practitioners directly involved with organizational upstream management theories and practices. All tools/joint practices in the area of organizational upstream management cannot be discussed in this research. Instead, only tools/joint practices perceived effective and more useful than others are introduced.

As the importance of quality organizational inputs received increased emphasis in recent years, many related data and information have become abundant in the area of quality management of organizational upstream systems. Traditional Japanese firms have

paid much attention to the relationship between a buying firm and suppliers, which made high quality organizational inputs from suppliers to organizational purchasing departments possible. However, traditional U.S. firms have emphasized the quality of the transformation process (q3 of Figure 1-1). This, in some regards, ignored the importance of q1. However, this traditional quality management approach has changed, and has become more similar to the Japanese approach. Managing quality effectively is important for all companies because, in most cases, companies buy from suppliers, and are suppliers to someone else (Winchell, 1987).

In this section, q1-q3 tools/joint practices from the literature and practices that have enabled some U.S. firms to change their strategies for upstream management are introduced. It is almost impossible to introduce all these tools/joint practices, and also, these tools/joint practices are always used in the combination with other tools/joint practices. These tools/joint practices are divided into two groups: How to establish an effective source of supplier base, and how to maintain high quality organizational inputs thereafter.

A.1.1 Tools/joint practices for selecting and establishing an effective source of supplier base

This section considers comprehensive tools/joint practices ranging from supplier selection to how to build a partnership. Tools/joint practices in this section will help organizations answer questions such as "What is a desirable relationship between a buying firm and suppliers?", "How can we build that desirable relationship?", "What are organizations doing to secure and maintain an optimal supply chain?", and "How can we select the best supplier under certain situations?" Some tools/joint practices may overlap in their contents and characteristics with other tools/joint practices in this section and the next. So some specific tools/joint practices in this section may be used in specific situations by one organization, whereas the same tools/joint practices can be used in other situations by another organization.

In the current manufacturing environment, the product line is designed to be managed at earlier business stages so that benefits of earlier business decisions pay for the additional front-end investment needed to fund new products (Engwall, 1991). Likewise, in managing the supply chain, managers in the upstream system should pay more attention to the early stage of establishing business relationships with suppliers.

The tools/joint practices that are discussed below may be representative ones that include characteristics of similar tools/joint practices. In other words, the tools/joint practices below may be named differently by people in different situations. Therefore, several similar tools/joint practices have been combined.

A.1.1.1 Strategic Supplier Partnering (SSP)

In today's competitive environment, companies are experiencing increased customer emphasis on quality, advanced state-of-the-art product performance, and timely deliveries. In this environment, partnering with qualified and preferred suppliers is of great importance. A supplier, whose performance can seriously affect the buyer's commitments, should be selected through defined supplier partnership procedures (Winchell, 1987).

Most research on supplier selection focuses on the quantifiable aspects of the supplier selection decision, such as issues of cost, delivery reliability and other similar factors. These are important criteria that should be considered in virtually any supplier selection decision. However, firms are becoming increasingly involved in a strategic partnership type of relationship with suppliers. This is because firms have discovered that close partnerships with important suppliers can produce managerial, technological, and financial benefits.

Compared to traditional competitive-coercive practices whose focus is on the current transaction rather than the relationship between a buying firm and suppliers, the SSP's focus is on the relationship rather than on individual transactions. Traditionally, one of the most important objectives of the purchasing function has been developing a network of competent suppliers. In this sense, the SSP should receive more attention, because it

provides a mechanism that guarantees a few preferred suppliers to a buying firm. There are several different definitions for the SSP, based on specific situations. Some of the definitions that fit fall under the scope of this research are:

- An agreement between a buying firm and suppliers that involves a long-term commitment, sharing of business strategies, and risks, etc. (Ellram, 1991).
- A cooperative and collaborative way in which buying firms and a few of their key supplying firms intensively interact with each other to achieve mutual win-win long-term competitive benefits (Ellram & Hendrick, 1993).
- Long-term relations with a few suppliers, close interactions between a number of different function boundaries, supplier proximity and blanket contracts that signal partnership-like interactions (Spekman, 1988).
- As a conduit for innovation, and one that rests on long-term mutual dependency between a buyer and suppliers who can guarantee high quality and fast, reliable delivery (Shapiro, 1985).

There are similar characteristics among these definitions, and important attributes that exist in cooperative buyer/seller relationships can be derived: a supply pool consisting of one or a few suppliers, an alliance incorporating a credible commitment between the buyer and selling firms, joint problem-solving activities, an exchange of information between firms, and joint adjustments to marketplace conditions.

Ellram (1991) has suggested potential advantages of forming SSPs based on her literature review and case studies of some selected firms, as shown in Table A-2. Hendrick & Ellram (1993) have conducted case studies on 100 firms, both inside and outside of the U.S., that are using SSPs . Their results deal with such comprehensive aspects of business transactions that it is impossible to cover all of them here. Therefore only facts related to this research are summarized in Table A-3.

Once organizations recognize the potential advantages of forming purchasing partnerships, the problem becomes how to form such SSPs. Based on Ellram's suggestions and Shewart's PDSA cycle, the following purchasing partnership development model can be derived. Figure A-1 appears very simple, but it involves much more managerial activities than one might expect. Once a purchasing partnership is created, successes, in addition to the advantages mentioned in Tables A-2 and A-3, can be achieved. These additions are: the partner's contribution of value-adding activities,

Table A-2. Potential Advantages of Forming SSPs
(Adapted from Ellram, 1991 and 1990)

Management
   1. Reduced supplier base is easier to manage.
   2. Increased mutual dependence lowers risk of losing supply source and creates
       greater stability through increased supplier loyalty.
   3. Reduced time looking for new suppliers/gathering competitive bids.
   4. Allows for joint planning and information sharing based on mutual trust and benefit.
   5. Loyalty may increase supplier attention and customer service in areas such as:
       • lead time reliability,
       • priority in times of scarcity,
       • increased attention when problems arise.
   6. Greater cooperation from suppliers to support the firm's strategy.

Technology
   1. Partners may be more willing to share/give access to technology.
   2. Partners may be more willing and capable of participating in product design based
       on knowledge and commitment to the other partner.
   3. Supplier knowledge/involvement in design may
     • improve quality,
     • reduce time to market for new products/design changes.

Financial
   1. May share business risks through
     • joint investment,
     • joint research and development, and
     • sharing of financial risk associated with market shifts.
   2. Information sharing/forecasting may reduce inventory levels.
   3. Long-term commitment of a partnership may lead to more stable prices.

Culture
   1. Feeling of trust.
   2. Management attitude/outlook for the future.
   3. Strategic fit.
   4. Top management compatibility.
   5. Compatibility across levels and functions of buyer and supplier firms.

effective personnel use by reduction in the number of suppliers used, and the frequent interactions that make communication more effective.

In order for this SSP model to succeed, some fundamental managerial factors should be required from management levels, along with technical support. Examples of success factors are top management support, total quality management initiatives, two-way information sharing, shared goals, and suppliers' efforts to add distinctive values. On

Table A-3. Summary Results of Case Studies on Performance of Firms Using SSPs (Summarized from Hendrick and Ellram, 1993)

Mean percent of respondents reporting price paid/charged for item

	Buyers' response	Suppliers' response
Above market price	9	4
At market price	35	50
Below market price	56	46

Estimated mean operating improvements

Defects (mean percent)

Incoming defects		
at inception of partnership	11.60	6.85
today	7.68	3.50

On-time delivery (mean percent)

On-time delivery		
at inception of partnership	79.94	86.84
today	91.31	95.06

Orders received complete (mean percent)

Orders received complete		
at inception of partnership	89.28	87.66
today	96.59	95.31

Cycle time (mean days)

Cycle time (from order to receipt)		
at inception of partnership	69.90	56.88
today	46.85	32.95

Economic benefits to buyers from SSPs	Economic benefits to suppliers from SSPs
Price reduction	Long-time business visibility
Defect reduction	Increased profits
Inventory-cost reduction	Schedule stability
Lead time reduction	Work force stability
Downtime reduction	Inventory reduction
Scrap/rework reduction	Lead time reduction
Engineering change reduction	Scrap/rework reduction
Work force cost savings	Engineering change reduction
	Financial support
	Technical support

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┌─────────────────────────────────────────────────────────┐
│                                                         │
│        ┌──────────────────────────┐                     │
│        │ Phase 1: Preliminary Phase│◄──────────┐        │
│        │ Establish strategic need  │           │        │
│        │ Form team                 │           │        │
│        │ Confirm top management    │           │        │
│        │ support                   │           │        │
│        └──────────┬───────────────┘           │ ACT    │
│                   │ PLAN/DO                    │        │
│        ┌──────────▼───────────────┐           │        │
│        │ Phase 2: Identify Potential│◄──┐      │        │
│        │          Partners         │   │      │        │
│        │ Determine selection criteria│  │      │        │
│        │ Identify potential partners │ │      │        │
│        └──────────┬───────────────┘   │      │        │
│                   │ PLAN/DO           │      │        │
│        ┌──────────▼───────────────┐   │      │        │
│        │ Phase 3: Screen and       ├───┘      │        │
│        │          Select           ├──────────┘        │
│        │ Contact potential partners│                   │
│        │ Evaluate partners         │                   │
│        │ Decision                  │                   │
│        └──────────┬───────────────┘                   │
│                   │ STUDY                              │
│        ┌──────────▼───────────────┐                   │
│        │ Phase 4: Establish Relationship│              │
│        │ Document expectation/contacts │              │
│        │ Provide high attention level  │              │
│        │ Give prompt feedback          │              │
│        └──────────┬───────────────┘                   │
│                   │ ACT                                │
│        ┌──────────▼───────────────┐                   │
│        │ Phase 5: Evaluate Relationship│              │
│        │ Continue at current level     │              │
│        │ Expand/build relationship     │              │
│        │ Reduce/dissolve interaction   │              │
│        └──────────────────────────┘                   │
│                        ACT                             │
└─────────────────────────────────────────────────────────┘
```

Figure A-1. Five Phases in the Development of a Purchasing Partnership

(Source: Ellram, 1991)

the other hand, to involve both a buying firm and suppliers in such strategic issues requires

a great deal of trust and sharing of confidential and otherwise strategically competitive

information and plans.

The SSP is also a good tool/joint practice from an economic perspective, which can be termed the "prisoner's dilemma" in game theory. Buyer-supplier relationships, like many other business transactions, can be explained by the underlying characteristics of the prisoner's dilemma; each party's pursuit of immediate gain can lead to an outcome that none of them likes. One way of overcoming this is to write contracts with each party promising to refrain from mutually damaging activity and making him/herself subject to legal sanction if the promise is broken. This proposition is now well known, and allows for repeated interactions, like contracts, and permits cooperation to occur. Repeating a game allows the players to escape the prisoner's dilemma. In an ongoing situation, people cooperate because it is in their interest to do so. Concern for the future may prevent a firm from squeezing the last cent of profit out of its trading partner. The point of the repeated-game argument is each party, especially the suppliers, cooperates for fear of being cut off from profits in the future. Business practice formalizes this notion by using numerical ratings. A supplier firm that performs well is given a higher rating, which increases the likelihood of its being awarded future contracts.

A.1.1.2 Global Sourcing

As U.S. firms struggle to maintain a world market share due to rapid changes in world competition, they tend to rely increasingly on international part sourcing to sustain competitiveness. Global sourcing is the integration and coordination of procurement requirements across worldwide business units, looking at common items, processes, technologies, and suppliers. It is different from international sourcing, which suggests that firms buy from foreign suppliers without systematic integration and coordination.

A Delphi study conducted by Monczka (1991) describes the importance of global sourcing. One result, 28 leading U.S. manufacturing firms' five-year performance goals, is shown in Table A-4. The first two items directly refer to the importance of global sourcing. What this Delphi outcome implies is that foreign sourcing, whether it is international sourcing or global sourcing, is necessary for survival and for securing cost, quality, technological, and other competitive advantages.

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Table A-4. Five-Year Performance Goals
(Adapted from Monczka & Trent, 1991)

- Year-to-year cost reductions of 5 percent, unadjusted for market economics.
- Year-to-year quality improvement in the range of 10 to 15 percent from existing world class levels (less than 250 part per million defects).
- A 40 to 60 percent reduction in "concept-to-market" product cycle time.
- An improvement in responsiveness to customer needs of 30 to 80 percent from current business unit levels, extending to 1995.

What are the steps for establishing global sourcing? Table A-5 explains four phases of achieving global sourcing and typical characteristics of each phase. As shown in Table A-5, Phase 1 and 2 are reactive to foreign buying practices. On the other hand, Phase 3 and 4 are proactive to foreign buying practices. These two phases indicate that a firm needs to think and act globally in order to source globally. Phase 1 is traditional domestic sourcing, which was the most popular sourcing practice during the 1960s and 1970s. Phase 1 firms often find themselves being driven toward Phase 2 because of triggering events in the supply market place. Such an event could be a supply disruption, a declining domestic supply base, or the sudden emergence of foreign competitors. Firms also shift Phase 2 to Phase 3 because of lower purchase prices and their significant performance improvements derived from foreign sourcing. Once a firm reaches Phase 4, it can achieve an overall procurement performance superior to the performance obtained within the other three phases. This phase represents true global sourcing, as opposed to basic international buying.

However, in establishing a global sourcing base, a firm is very likely to encounter many barriers ranging from emotional discomfort to organizational resistance. Examples of these barriers are a lack of the buyer's understanding of international purchasing practices, the buyer's resistance to change, domestic market nationalism, a decentralized buying structure, a lack of working knowledge about foreign business practices, and changes required to accommodate long lead times and a lengthened supply pipeline.

Table A-5. Characteristics of International Procurement Phases
(Summarized from Monczka, 1991; Hahn 1990)

Phase 1: Domestic purchasing only
- Low need for international or global sourcing
- Lack of sophisticated international data networks
- Foreign produced goods purchased through domestic sources

Phase 2: Foreign buying based on need
- As-needed international sourcing
- International information needs increasing
- Firm often reactively driven into this phase
- Limited international procurement capabilities of the firm

Phase 3: Foreign buying as part of procurement strategy
- Top management support of global sourcing emerging
- Global perspective of potential source markets
- Beginning of proactive inclusion of international sourcing strategy
- Greatest resistance to increased international sourcing
- Designated buyers, subsidiaries, or international procurement offices used for worldwide sourcing

Phase 4: Integration of global procurement strategy
- Greatest global sourcing benefits realized
- Information requirements critical
- Executive level manager designated to coordinate global effort
- Integration and coordination of global sourcing requirements to maximizing buying leverage
- Designing, building, and sourcing functions assigned to most capable business unit
- Full organizational and informational system integration required
- Global sourcing measurement and reward systems established

A.1.1.3 Vendor Profile Analysis (VPA)

It is sometimes helpful for a buying firm to use quantitative analysis to select the best supplier, given the suppliers' previous performance data. Quantitative methods usually provide a buying firm with objective criteria in making decisions on suppliers' performance. These objective data can substantially help trim a firm's operating costs. This enhances performance by suggesting an appropriate or optimal supplier. One of the

quantitative analyses – Vendor Profile Analysis (VPA) – has been studied by some researchers, and Thompson (1990) has introduced more advanced methods using simple computer techniques.

One of the most popular quantitative analysis methods is the weighted point method, which is simple to use because of its mathematical simplicity, flexibility, relatively low cost, and the quality of the results it produces. The VPA is an advanced quantitative analysis method using Monte Carlo simulation and a computer spreadsheet.

A.1.1.3.1 The Vendor Profile Analysis Model

One of the weaknesses of the weighted point method is that it is difficult to estimate or decide the suppliers' performance with high accuracy. The VPA is designed to overcome the limitation of the traditional weighted point method by incorporating decision makers' perceptions of the uncertainty surrounding suppliers' performance by using the Monte Carlo simulation technique. As input to the simulation algorithm, decision makers estimate ranges of expected performance for suppliers based on evaluation criteria rather than just single point estimates of expected values. The following mathematical model explains how the VPA works to select the best supplier.

$$A_{jk} = \sum_{}^{n} a_i b_{ijk}, \text{ where}$$

A_{jk} = summated score for supplier j on iteration k of the simulation

a_i = importance weight attached to evaluation criterion i

b_{ijk} = randomly generated performance rating on evaluation criterion i for supplier j during iteration k

n = number of evaluation criteria

Note that performance ratings for supplier on evaluation criteria (b_{ijk}) are randomly generated, rather than specifically estimated by decision makers. There is one critical assumption for using the VPA. Decision makers can accurately estimate a range of performance values as shown in the example in the next section. Consequently, decision

makers should be able to estimate reasonably high and low levels of performance for suppliers on each criterion.

The simulation algorithm provides random sample values (b_{ijk}'s) from within each performance range, and then combines these values with importance weights (a_i's) to produce a distribution of the summated score (A_{jk}'s). Each computer iteration generates A_{jk}, and this process is repeated up to several thousand times to build a frequency distribution of A_{jk}'s for each supplier. This frequency distribution represents the range of overall performance anticipated from that supplier.

The VPA uses computer simulation to calculate the average performance of suppliers on pre-determined performance criteria. Other than those data/information on the VPA, the equation and procedures to calculate the supplier performance should include at least three major factors: cost, schedule, and quality. Usually, an unacceptable rating in any of three factors is enough to give a supplier an unacceptable rating (Winchell, 1987).

A.1.1.3.2   An example

Table A-6 is a simplified application of the VPA. For this example, assume the same evaluation criteria and importance weights are used for all suppliers being assessed. Decision makers estimate reasonably high and low performance levels for suppliers on each evaluative criterion.

The procedure to obtain the summated score of 1601 is self explanatory, and in this example 1000 iterations are used to obtain the average score of an example supplier. Following the same procedures using different ranges of values for other suppliers on evaluation criteria, average scores for other suppliers can be obtained. Then, based on these average scores on suppliers' overall performance, procurement managers can decide who is the best supplier.

The above introduction and simplified example of the VPA include both subjective and objective components of decision making. In determining performance evaluation

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Table A-6. Example of VPA Application
(Taken from Thompson, 1990)

	(a$_i$)		(b$_{ijk}$)		(a$_i$b$_{ijk}$)
	VENDOR A				
	Importance	Estimated		Estimated	Weighted
Criteria	Weight	High	Sampled	Low	Value
Compatibility with present equipment	2	85	78	60	156
Speed of obsolescence	3	80	66	65	198
Engineering design services	5	90	81	60	405
Post-sale technical service	4	75	59	50	236
Economy in use of the product	4	100	84	65	336
Flexibility of system to accommodate future growth	3	90	90	70	<u>270</u>

Summated Score (A$_{jk}$):   1601

Table of Summated Scores

Iteration (k)	Summated Score (A$_{jk}$)
1	1601
2	1362
3	1746
.	.
.	.
.	.
1000	1491

criteria and their importance weights, decision makers' subjective ability to generate and estimate unbiased data/information is required. It is fortunate when longitudinal data/ information on suppliers' performance are available because these data/information can

provide an unbiased picture of the performance of each supplier. On the other hand, when making final decisions about who is the best supplier using the above subjective data/ information, decision makers can be confident about their decisions because every supplier is evaluated using the same criteria.

In some regards, a quantitative analysis such as the VPA used in selecting an appropriate supplier is different from Deming's approach. Deming asserted that rating and ranking are obstacles to better performance. However, Deming's approach may be used when a buying firm completely finishes establishing relationships with suppliers who secure all the parts and items it needs. The VPA can be used when a buying firm needs to establish or re-establish relationships with potential or other suppliers who have prior business relationships with the firm.

A.1.2 Tools/joint practices for improving the effectiveness of upstream management practices

This section considers tools/joint practices for managing and further improving the quality of organizational inputs. The previous section dealt with tools/joint practices related to establishing and building buyer-supplier relationships for advanced organizational upstream systems. After acquiring desirable supply chain relationships, the buying organization and the organization's suppliers need more tools/joint practices to manage and improve the quality of organizational inputs. For this purpose, this section discusses some tools/joint practices used by many leading organizational upstream systems.

A.1.2.1 Quality Audit (QA)

Quality Audit (QA) has recently been considered the most comprehensive quality tool/joint practice in the TQM area. The QA factors related to both the TQM perspective and organizational quality management efforts are first explained. Then, specifics about QA in terms of organizational upstream systems will be considered.

A.1.2.1.1   Quality Audit (QA) in General

A brief introduction to the QA will help us understand why tools/joint practices, such as QA, are necessary to manage and improve the quality performance of organizational upstream systems. First QA is defined as 'a systematic and independent examination to determine whether quality activities and related results comply with planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve objectives' (International Standard ISO 8402-1986).

In using the QA, one of the most important things to do in advance is to select an appropriate quality standard that fits into certain organizational activities. There are many well-organized and widely-used quality standards. Other than the ISO 9000 and MBNQA criteria mentioned already, the following four standards are recommended as appropriate standards for the QA:

- American National Standard, Generic Guidelines for Auditing of Quality Systems, ANSI / ASQC Q1-1986.
- American National Standard, Quality Assurance Program Requirements for Nuclear Facilities, ANSI / ASME NQA-1-1986.
- United States General Accounting Office, Standards for Audit of Governmental Organizations, Programs, Activities, and Functions, The Comptroller General of the United States, 1972.
- International Organization for Standardization, Guidelines for Auditing Quality Systems, Part 1: Auditing, Part 2: Qualification Criteria for Quality System Auditors, Part 3: Management of Audit Program, International Organization for Standardization.

It is beyond the scope of this research to explain each of above standards, but it is reasonable to select common facts about the QA from them. A standard is a document outlining the mandatory minimum requirements for auditors, auditing, audit reports, and audit follow-up. Standards also deal with audits of quality assurance programs and other similar management planning and control programs. The purpose of the QA can be explained depending on the specific activities of organizational transformation processes. However, the following purposes are common to more than one standard:

- to establish the basis for guidance and measurement of audit performance and to improve auditing,

- to delineate requirements for establishing and implementing a system of internal and external audits that would apply to quality assurance programs,
- to establish basic audit principles, criteria, and practices and to provide guidelines for establishing, planning, carrying out, and documenting audits of quality assurance systems.

It should be noted that QA is an active quality management tool/joint practice rather than control and monitoring tool/joint practice. More information on QA can be found in references cited at the end of this research.

A.1.2.1.2   Quality Audit for Upstream Systems

There are many quality tools/joint practices available for upstream systems. However, the QA is more comprehensive and powerful than many other tools/joint practices in terms of its scope. It is very important to match quality tools/joint practices with specific upstream systems because some tools/joint practices work better in certain situations.

There are two kinds of QAs: internal and external. The internal QA is conducted by auditors employed by the organization being audited. The audit may be conducted by an individual or by a team selected from audit specialists, managers, executives, etc. Since these individuals are involved with the quality system of the organization being audited, they may not be objective enough to assess the suitability of their quality program against some external standard. Executives would be in a position to assess such suitability relative to the organization's quality policy. Normally, the internal quality audit is involved with evaluating the conformance of the various activities to the quality program and the effectiveness of the quality system. If the internal QA is used from the upstream system perspective, that is, from the relationship between the supplier and the procurement department of the organization, the internal QA is one where the supplier carries out a comprehensive system of planned and documented internal quality audits to verify whether quality activities comply with planned arrangements and to determine the effectiveness of the quality system. Audits are scheduled on the basis of the status and importance of the activities. The results of the audit are documented and brought to the

attention of the personnel responsible for the area audited. The management personnel responsible for the area shall take timely corrective action on the deficiencies found by the audit team.

The external QA is conducted by auditors who are not members of the auditee's organization. In this case where the auditee is also the client, the auditors are specialists from outside the organization. They are hired to conduct an independent audit. Unlike the internal QA, typical external QAs include the following major activities:

- Quality system certification or registration: Audit an organization's quality system with respect to national or international standards and then provide registration or certification of acceptable programs.
- Vendor appraisal: A technique used by many major contractors to evaluate the ability of a potential supplier to provide a particular product, service, or process.
- Product liability insurance: Audit on the nature and the amount of business transacted, the risk of liability actions arising, and the probable cost resulting from any litigation that might arise.
- Corporate quality audit: Audit on assessing how effectively an organization's various divisions are conforming to the quality policies of the corporation.

There are other activities related to managing suppliers and the quality of procured organizational inputs. The following two items deal with major activities closely related to the upstream system.

- Vendor Appraisal: A vendor appraisal will normally cover all aspects of the potential supplier including financial stability, design capability, manufacturing capability, and quality systems. Quality audit techniques can be useful in appraising these areas. This type of evaluation will frequently be initiated as the result of the quality system requirements placed on the prime contractor by such standards as MIL-Q-9858A, ISO 9001, and ISO 9002. The reference standard for a vendor appraisal may be a national or international procurement quality standard or a standard developed by the contractor. The extent of the audit will depend on the nature of the work to be undertaken, the application of the item concerned, the maturity of that item, etc. Once the contractor has been selected, periodic quality audits or appraisals may be carried out to confirm conformance to the agreed-upon quality system.
- Corporate Qualified Supplier List: A particular vendor appraisal develops a corporate qualified supplier list. Organizations approved by a corporation through vendor appraisals are listed by product line or business type. The list forms the basis for contracting potential suppliers for future business. Listings like this are also helpful when using corporate purchasing agreements in which divisions or subsets of a corporation combine purchases to get a better price break. Combining orders can also

assure that the supplier maintains its goods or services at a satisfactory quality level. The larger quantities make it easier for statistical process control methods and other forms of statistical quality control to monitor, control, and improve quality levels.

A.1.2.1.3   Quality Audit from the TQM Perspectives

Regardless of the types of QA, QA activities can be divided into four steps: planning, performing, measuring, and improving. Figure A-2 illustrates these cyclical quality steps.
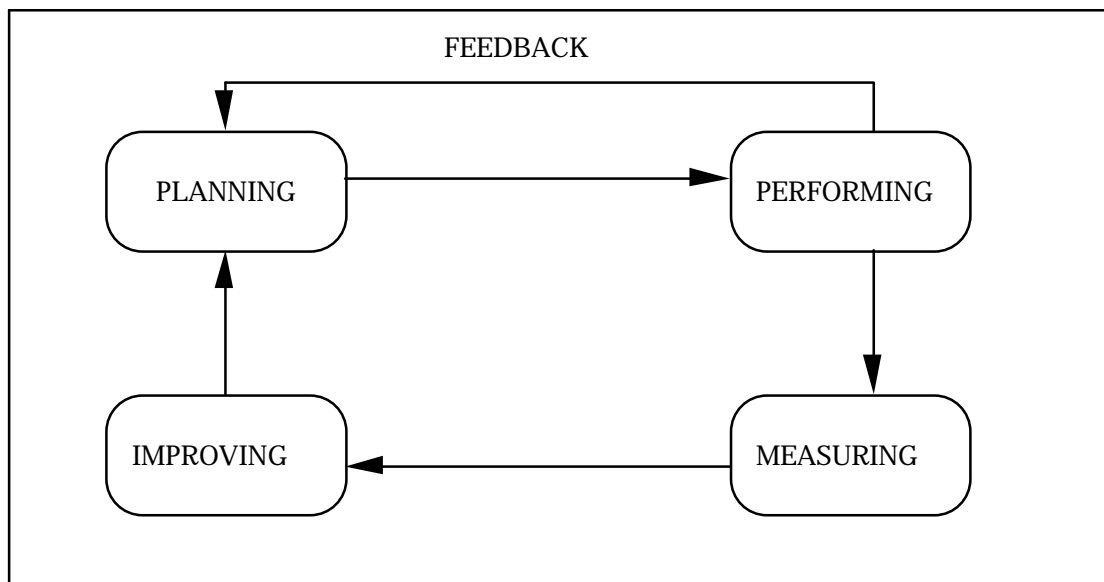
Figure A-2. Qaulity Audit Cycle
(Source: Arter, 1989)

- Planning: The activities performed should be planned before they happen. Responsibilities must be set so accountability and ownership of the resulting performance is established. The identity and needs of the customer should be defined. Requirements should be specified in written documents that describe the work activity or products ordered. These are the requirements quality is measured against.
- Performance: The action should proceed as planned. Records should be kept so measurement can take place. Those performing the tasks should be given the proper tools/joint practices and training to accomplish the job as specified.

- Measurement: The success (or failure) of an activity needs to be measured against some accepted standard. Tools/joint practices used include inspection, surveillance, audit, appraisal, and review. All involved in the activity should be aware of the quality as measured. Feedback from the customer is also vital to success.
- Improvement: Problems must be corrected and the process improved. Managers and employees can share improvement ideas, but the ultimate responsibility for improvement lies with management. Any changes should be communicated to the customers.

In some regards, the QA cycle in Figure A-2 is similar to Deming's Plan-Do-Study-Act (PDSA). Deming's PDSA cycle is a flow diagram for learning and for improving a product or a process in general (Deming, 1993).

A.1.2.2 Just-In-Time (JIT) Purchasing

The fundamental concept of JIT is eliminating waste caused by overproduction, unnecessary handling, inefficient processing, and defective production (Japan Management Association, 1986). In its purest sense, JIT production requires frequent deliveries in small quantities, extremely exacting quality requirements, and using long-term contracts with a reduced number of suppliers (Schonberger, 1984).

Quality is as major a consideration in applying the JIT technique to purchasing as it is to production. The literature has already presented the advantages and disadvantages of JIT purchasing practices. Billesbach, Harrison, and Croom-Morgan (1991) found a number of significant, tangible benefits from using JIT purchasing practices, particularly in the area of inventory reduction, quality conformance to specification, and delivery reliability. Some of the significant outcomes of their research are also found in other JIT related sources. Some of those benefits have been combined, and the results are shown in Table A-7.

There are other advantages defined in various studies on JIT. The following are the specific benefits directly related to the quality of organizational upstream systems.

- Supplier selection: Using JIT, buying firms can maintain a smaller number of pre-selected and preferred suppliers. In maintaining this smaller number of suppliers, the buying firms can even limit the geographic dispersion of suppliers. This allows the buying firm to visit frequently the suppliers' production lines, so better and faster

technical communication is possible. It is quite predictable that the quality of procured items will be increased by frequent on-site visits and face-to-face technical communications.

Table A-7. Some Benefits of JIT Delivery
(Adapted from Raia, 1990)

	Before JIT	1990	1992
On-time delivery	62% (17 days)	79% (7 days)	94% (2 days)
Number of suppliers per plant	402	252	160
% of certified suppliers	2.3	20	54
Raw materials on hand (in weeks of production)	9.5	4.8	2.2
% of suppliers delivering on daily basis	2.3	9.4	23.5
% of deliveries subject to inspection	79	61	34

- Supplier evaluation: Because of its effort to maintain a smaller number of preferred suppliers, buying firms need to evaluate potential suppliers based on their ability to provide high quality products. To be included in the qualified supplier list, suppliers must put more emphasis on their product quality.
- Product and process design: Increased communication and information exchanges through face-to-face meetings and electronic data interchanges help suppliers have more discretion in product and process design, and manufacturing methods. If suppliers understand the buying firm's production process, it will be easier for them to meet the buying firm's requirements.
- Cost reductions from non-JIT practices: Traditional supplier selection and evaluation practices usually involve bidding and negotiation processes and receiving inspections. Most of these traditional processes are cost-generating factors. These steps inevitably generate a lot of paperwork, which requires more processes. Without bidding and negotiation processes, suppliers can afford the cost of long-term commitment to meet (or sometimes exceed) quality requirements. Eliminating receiving inspection assumes that suppliers can give quality inputs to buying firms. This can be achieved with the vendor certification program. This certification program increases quality at the source.
- Lot size and frequency of delivery: Major characteristics of JIT are production of small lot sizes and more frequent deliveries. Producing small lots means steady

production rather than production in batches. In turn, this means that suppliers need to have flexible manufacturing systems to reduce inventory and scrap levels and to increase the quality of their product. Frequent delivery of small lots reduces the buyer's and supplier's inventory levels and associated cost.

- Early detection of defects: Defects can be detected at different point in time during the design phase, at the suppliers' facilities during receiving inspection, during and after production, and while products are being used by the customer. Frequent and more information and communication between a buying firm and its suppliers using JIT purchasing concepts can help detect defects in the early stage of the design phase. The best time to catch problems is during the design phase. If a product is poorly designed, the best supplier, production, and inspection personnel cannot do much to improve it.

There are also many intangible, but unique advantages to JIT purchasing. These include long-term relationships between a buyer and suppliers, a reduction in paperwork, better production scheduling, etc. Although it is difficult to quantify these benefits, firms that have adopted JIT purchasing have reported greater intangible benefits than those derived from traditional purchasing practices.

To benefit from JIT, the organization or its procurement department must do some pre-work for systematic JIT practices. The following are necessary for effective JIT purchasing practices:

- Vendor verification: Frequent delivery of defect-free materials is one important objective of JIT purchasing. One way to meet this objective is to eliminate the receiving inspection of incoming materials. The abolition of the receiving inspection can be done by vendor certification in conjunction with a quality audit of an organization's upstream system (Ware, 1984). When vendors consistently meet the quality standard set by buyer and seller, the buying firm does not need to conduct a traditional receiving inspection.
- Electronic Data Interchange (EDI): Vendor certification and cooperative buyer/seller relationships result in open information sharing between buyer and supplier regarding product design, process modification, purchase orders, and other business transactions. This increased exchange of information can be improved by EDI. Some Japanese companies and large U.S. auto industries are already taking advantage of EDI by requiring their suppliers to be hooked up to a computer network.

A.1.2.3 Quality Function Deployment (QFD)

The QFD is another comprehensive tool/joint practice that suppliers can use to manage quality and other performance criteria. In this section, general facts about the QFD are introduced, and then, specifics about the QFD that can be applied to organizational upstream systems are examined.

A.1.2.3.1   QFD in General

QFD was developed in 1972 at Mitsubishi's Kobe shipyard site. Toyota and its suppliers then developed it in numerous ways, and it has been used successfully by Japanese manufacturers of consumer electronics, home appliances, clothing, integrated circuits, synthetic rubber, construction equipment, and agricultural engines (Hauser and Clausing, 1988). Ford and Xerox brought QFD to the United States in 1986, and, in the past several years, it has been adopted widely by U.S. and European firms as well as by Japanese industries (Hauser, 1993). The QFD is a conceptual map for inter-functional planning and communication between customers and suppliers and within the different functions of the organization. As a set of planning and communication routines, QFD focuses on skills within an organization and fosters continuous communication and coordination between customers and suppliers to design and then to manufacture and deliver the products and services that customers want. QFD is based on the belief that products should be designed to reflect customers' desires and tastes. This means the supplier's and the customer's staff must work together from the time a product is first conceived.

A.1.2.3.2   QFD Applied to Organizational Upstream System

QFD uses four "houses" to integrate informational needs. Figure A-3 shows the conceptual shape and basic elements of QFD, and also demonstrates why it is sometimes called the "House of Quality." In this section, a more general description of QFD and its elements is provided, along with a specific example of upstream systems.
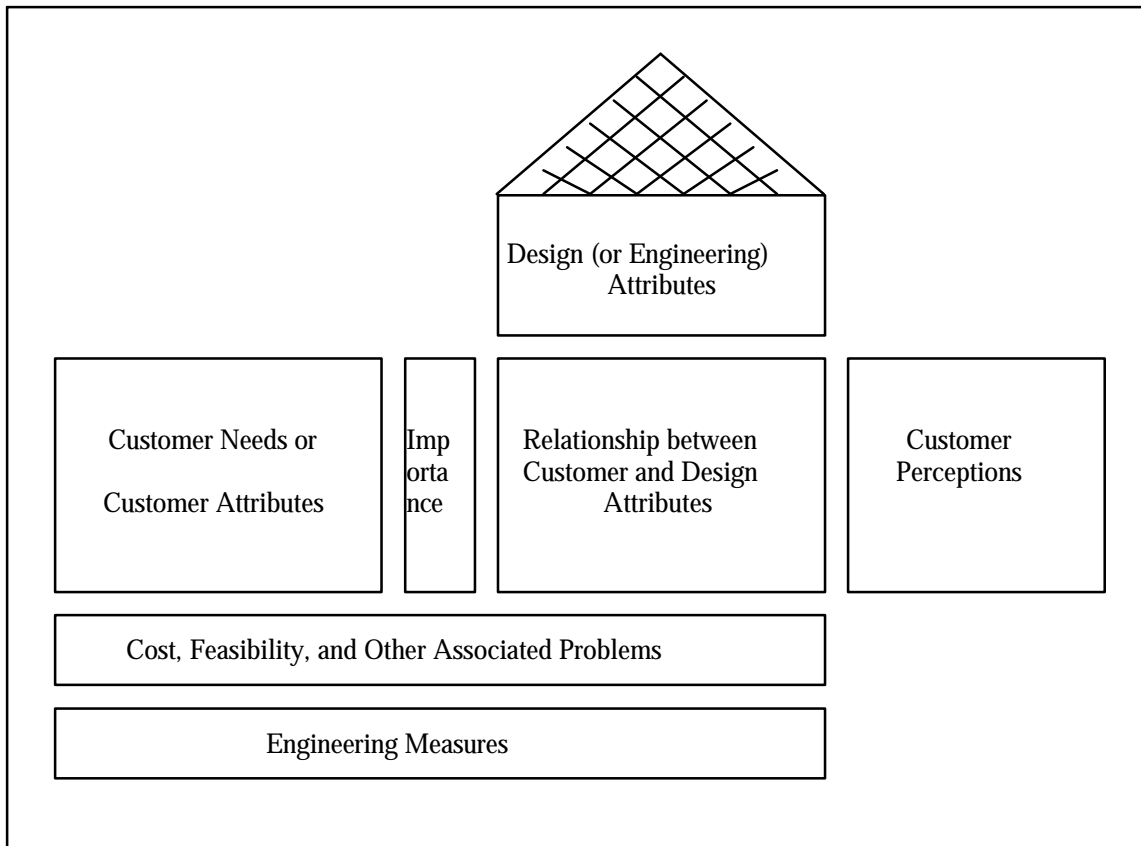
Figure A-3. QFD (House of Quality)
(Source: Hauser and Clausing, 1988)

- Identifying customers' needs ("Customer needs room"): The first step of QFD is identifying customer (buyer) needs. These product and service needs are described by the customer. In upstream system practices, these customer needs are presented through the specifications or other order forms to the suppliers. Traditionally, these specifications are completed by the buyers' procuring officers without the suppliers' cooperation and intervention. This is why the buyers' and the suppliers' have had problems in communicating overall performance criteria and detailed specifications. These buyer needs can be determined by the buyers' procuring officers with the help of experienced supplier personnel. As mentioned before, because of previous and current business experience, the suppliers are sometimes more knowledgeable and informed about organizational inputs, whether they are parts or half-completed products. After identifying buyers' needs, the supplier sometimes has to structure buyers' needs into the appropriate numbers of hierarchies if there are relatively large numbers of buyers' needs. Table A-8 is an example of buyers' needs (left: commercial area, right: government procurement contract) and their categorized hierarchies.

Table A-8. Customer Needs and Bundles of Customer Needs

Automobile case		Aircraft case	
Easy to open and close door	Easy to close from outside Stays open on a hill : :	Safety	Prepare extra backup engine Install high quality radar : :
Isolation	Doesn't leak in rain No road noise :	High tech	Shouldn't be detected by enemy Perform specific task in short time period :
: :	: :	:	:

- Prioritizing the needs ("Importance room"): The buyer wants its needs fulfilled, but some needs are more important than others. The supplier's prioritizing helps the QFD balance the cost of fulfilling a need with benefit to the customer within limited resources. For example, if fulfilling two needs cost equally, then the more important need has higher priority.
- Comparing customer perceptions ("Customer perceptions room"): The buyer's perceptions of how well the supplier's previous and current products and competitive supplier's products fulfill buyer's needs help the suppliers guide product and service design. By understanding which supplier fulfills its customer's needs best in a specific area, how well the buyer's needs are fulfilled, and whether there are any gaps between the best supplier and others, the QFD personnel of the specific supplier can identify goals and opportunities for product and service design.
- Identifying design attributes ("Design attribute room"): This room involves translating buyer's needs into engineering concerns. The suppliers' QFD team needs to identify measurable requirements that will fulfill the buyer's needs. Identifying all design attributes for the buyer's needs is not easy, but this job should be done to better meet the buyer's needs. In some cases, when the buyer also has insight on the production of specific items, the supplier can better identify its design attributes with the buyer's help.
- Developing the relationship matrix ("Relationship between customer and design attributes room"): The supplier now judges which design attributes influence which buyer's needs and how much. The idea is to specify the strongest relationships between buyer's needs and supplier's design attributes, while leaving most of the matrix blank because too many relationships cannot be reflected in product design and development. Nor can they fulfilled when the final procured item is delivered to the buyer.

- Developing the roof matrix: This matrix, symbolized in the figure by the cross-hatched roof, quantifies the physical relationships among design attributes. For example, if two design attributes are related, one attribute may have a positive/negative influence on the other attribute. However, when possible, the supplier will seek creative solutions to improve both.   In developing relationships and roof matrices, simple symbols and marks are used to show the degree of relationships. For example, strong positive, medium positive, and strong negative, medium negative, or strong, moderate, and weak, and so on.
- Adding engineering measures: Once the supplier has identified the buyer's needs and linked them to design attributes, it needs to add engineering measures at the bottom of the house. When engineering measures are known, the supplier can eventually move to establish target values – ideal new measures for each design attribute in a redesigned or new item procured.
- Cost, feasibility, and other associated problems: Most buyer specifications and requirements can be addressed and possibly improved by using parts of QFD that have been explained previously. But some factors, such as technical difficulties, relative importance, estimated cost among design attributes, and whether or not each design attribute complies with laws and regulations imposed by the government regulatory bodies cannot be addressed in the QFD elements mentioned above. The cost, feasibility, and other associated problems room does address these issues. Some relationships between buyer's needs and supplier design attributes, or among design attributes, can be used to take appropriate action if the relationships are clearly identified by a relationship matrix and a roof matrix, whether these relationships are positive (the supplier needs to select certain design attributes to fulfill buyer's needs) or negative (the supplier doesn't need to take any action because of the negative effects resulting from either the relationship matrix or roof matrix, or both). But in other cases, the supplier cannot make any decision on whether it needs to exert some effort to fulfill the buyer's needs or not, because those relationships between the buyer's needs and supplier design attributes, or among design attributes, are not clear from the relationship matrix and roof matrix.   In this case, the cost, feasibility, and other associated problems room helps suppliers make the final decisions. The supplier can get additional information from this room if it cannot determine what to do, because the data and information between the relationship matrix and the roof matrix are unclear.

The QFD is used to improve other performance criteria as well as the quality criteria of organizational upstream system practices. The buyer and the supplier work together to address the important performance criteria for the customer's needs and the design attributes elements of QFD. They do this by carefully identifying key performance indicators for each performance criterion.

A.1.2.4 Single-sourcing and multi-sourcing

Should the buyer use a single supplier or multiple suppliers? It is difficult to say that single-sourcing is better than multi-sourcing. The decision depends on the characteristics of business transactions and the overall situation of the firm's operation.

Advantages of multi-sourcing include a greater degree of flexibility in technical areas, protection in times of shortages against failure at a suppliers' plant, and competition among suppliers in order to secure the best possible price and products. On the other hand, the advantages of single-sourcing include a minimum investment of resources such as buyers' and engineers' time, consistent quality (because when the buyer deals with fewer suppliers and involves them in the early stages of program design, suppliers can provide consistently high quality products), lower cost (because the overall volume of items purchased from any supplier is higher), special attention from suppliers (since the buyer represents large accounts), a minimal amount spent to provide tooling for suppliers, easily scheduled deliveries since all orders are placed with one supplier, and long-term relationships, which encourage supplier loyalty and reduce the risk of an interrupted supply of parts to the buyer's plant.

In theory, a large number of suppliers provide competition that reduces a buyer's cost. But in practice, administrative costs are excessive and buyer quality assurance resources are spread too thinly to be effective (Pence & Saacke, 1989). Consequently, leading U.S. companies have slashed a large portion of supplier bases, and have focused their business and quality assurance attention on a few preferred suppliers, not on a single supplier. By significantly reducing the supplier base, buying organizations are drastically diminishing competition among their remaining suppliers. This creates a healthy atmosphere for improving supplier effectiveness. The result has been closer and mutually-beneficial buyer-supplier relationships.

As buyer-supplier relationships have improved and deepened, buying organizations can enjoy additional benefits of supplier initiatives beyond specific steps (e.g., supplier reduction) and programs (e.g., JIT). These might be called additional value creation from

which suppliers actively seek ways to reduce buyer costs, not by reducing quality, but by constantly questioning what is needed and how it should be done. In some cases, this process is formalized through cost targeting, which involves the buyer and supplier working together as a product-design-&-development team to come in at a set cost. At the other extreme of successful cases are companies that tell trusted suppliers what they want and give them virtually total latitude in providing it.

One special case of implementing both single and multi-sourcing is found in Cross (1995).   In his case, British Petroleum's information technology is outsourced. In his article, Cross proposes a single supply method in which multiple suppliers cooperate with each other to give the BP what it wants from suppliers. This is a special case of using both methods, but in most cases, the method the buyer should use depends on the characteristics of the situation − items supplies, contract methods, etc. − and the buying and the supplying firms' supply strategies.

A.1.2.5 *Performance measurement tools/joint practices*

Over the years, research and experience have shown that feedback to organizations and individuals is a key motivation affecting future performance (Mescon, Albert, & Khedouri 1980). But ironically, there hasn't been enough research investigating the performance of organizational upstream systems. In this section, some of the performance measurement tools/joint practices that are available and widely used for the organizational upstream system are considered.

A.1.2.5.1   Performance Measurement Criteria for JIT purchasing

Compared to other tools/joint practices used in managing the quality of organizational upstream systems, JIT purchasing uses more specific performance criteria. Some of them can also be used in other purchasing practices. One survey conducted by Giunipero (1990) identified both increasing and decreasing performance criteria for JIT purchasing practices. These are shown in Table A-9.

Table A-9. The Use of Performance Measurement Criteria under JIT
(Source: Giunipero, 1990)

Increasing Use under JIT	Decreasing Use under JIT
Reduction in number of suppliers	Cost reduction savings
Reduction in supplier lead time	Lower price per unit
Improvement in supplier quality	Purchase price variance
Improvement in supplier delivery	End of month shipment
Increased inventory turnover	
Inventory reduction in total dollars	

First of all, it is very interesting to note the four items in the right portion of the table have been used in traditional organizational transformation processes as major performance criteria. However, all of them are identified as decreasing performance criteria under JIT purchasing practices. On the other hand, a reduction in the number of suppliers, a reduction in supplier lead time, and the other four items in the left portion of the table are increasing performance criteria under JIT purchasing practices. Those observations on performance criteria are quite predictable and can be used in other upstream system practices as well.

A.1.2.5.2   Benchmarking

Benchmarking is a strategy many companies use to plan and improve performance. Benchmarking uses both traditional indicators (e.g., price per unit, etc.) and many new indicators (e.g., on-time delivery, number of significant suppliers involved in design, etc.) . Benchmarking as introduced in this section can be used specifically by suppliers to improve their performance because it can be compared with other world leaders in the same area. Every company uses different forms of benchmarking processes, but there are commonalties among their detailed steps. One example is introduced in Table A-10.

Benchmarking can be done to establish a statistically meaningful database. Selecting the comparative companies to be benchmarked often comes from longitudinal

business experiences. Other methods include using personal contacts in other companies, data from trade journals, and interviews with customers.

**Table A-10. Typical Benchmarking Processes
(Adapted from Bemowski; 1991 and Cali; 1993)**

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Planning
- Identify what is to be benchmarked.
- Identify comparative companies.
- Determine the data collection method to be used and collect the data.

Analysis
- Determine current performance gap.
- Project future performance levels.

Integration
- Communicate benchmark.
- Establish functional goals.
- Develop action plans.

Action
- Implement specific actions and monitor progress.
- Recalibrate benchmarks.

</div>

Most steps shown in Table A-10 can be done at the subsystem level, such as the purchasing department. But to achieve the goals set by benchmarking processes, part of the processes should be integrated into the larger system level strategic performance improvement planning process (SPIPP, Sink; 1989) or communicated with another related department.   The job of integration may be critical to the success of benchmarking at the subsystem level because the integration of benchmarking at the subsystem level into the larger system means involving the support of top management.

There are many more qualitative and quantitative tools/joint practices used to measure the performance of organizational upstream systems, but some are too specific to be discussed here. Tools/joint practices may be used in combination with other tools/joint practices to measure performance. For example, the QFD cannot be implemented without

using performance indicators or gaps identified by benchmarking. It is important to select appropriate tools/joint practices that can work in harmony.

A.2   *Review of the specific tools/joint practices in section A.1.1 and A.1.2*

Previous sections have described two major quality tools/joint practices in two groups – how to establish an effective source of a supplier base and how to maintain and improve the quality of organizational inputs thereafter. These can be widely used in organizational upstream systems to increase the quality of organizational input. Of course, there are many more quality tools/joint practices that can be used in organizational upstream systems. These include developing robust measurement systems, education and training programs for suppliers and procurement-related personnel, and so on. The focus has been on these two groups of quality tools/joint practices because they are readily available in terms of the depth of the body of knowledge in academic and practitioners' areas and they are effective when used by organizations.

It does take time and effort (both physically and mentally) for buyers and suppliers to adopt these quality tools/joint practices. For example, with QA, buying and supplying companies should be prepared for groundwork, such as the quality programs and quality systems mentioned. They must also decide which standard to use and plan regular or irregular internal or external audits. For JIT, they need to establish pre-requisite conditions, such as an electronic data interchange network, vendor verification programs, and cooperative buyer/seller relationships. Unless they do this, they will not succeed.

The tools/joint practices, in some regards, cannot be used separately. For example, vendor certification programs of JIT should be done by quality audits. Also there is a lot of interaction between the two tools/joint practices. If buyers and suppliers decide to adopt JIT purchasing practices, they should also consider the accounting aspect of the quality audit. Traditional accounting audits rely heavily on available paperwork related to purchase orders and associated transactions. However, JIT purchasing practices will reduce paperwork, which means the steps and methodologies of accounting audits should be modified to cope with problems associated with reduced paperwork.

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Success or failure of the quality tools/joint practices proposed in this research rely heavily on two factors. First, to succeed in managing and improving the quality of organizational input, managers should maintain a balance among the tools/joint practices they intend to use. As mentioned, it is almost impossible for one specific quality tool/joint practice to help managers obtain their goals. Managers should consider at least three or four, or sometimes more, tools/joint practices when they implement and deploy plans related to the organizational upstream system. Some companies may need more QFD and JIT purchasing than other tools/joint practices, and others may need more QA and VPA than other tools/joint practices. Whatever tools/joint practices they need, it is important to maintain the balance among the tools/joint practices used in certain situations.

The second factor impacting the success or failure of these tools/joint practices is top managers' intention to succeed in their efforts to improve the quality of their organizations' inputs. Rather than abdicating important responsibilities to their subordinates, they should be actively involved in the major processes of the organizational upstream system processes such as planning, reviewing, and updating.

In conclusion, the following conceptual model indicating the potential benefits of tools/joint practices for upstream management is proposed to summarize what has been explained, and to suggest a new direction for further research. One of the results of the tools/joint practices for establishing a desirable source of supplier base (section A.1.1) is joint action between buyers and suppliers. This is shown at the top of Figure A-4. Then, supported by this joint action, the tools/joint practices introduced in section A.1.2 such as QA, JIT purchasing, QFD, and single or multi sourcing can generate major advantages, shown at the *1st level major advantages* part of Figure A-4. The highlighted *1st level major advantages* of each tool/joint practice will again produce another major advantage, shown at the *2nd level major advantages* part of Figure A-4. In turn, this directly influences the improvement of the effectiveness of upstream management practices.
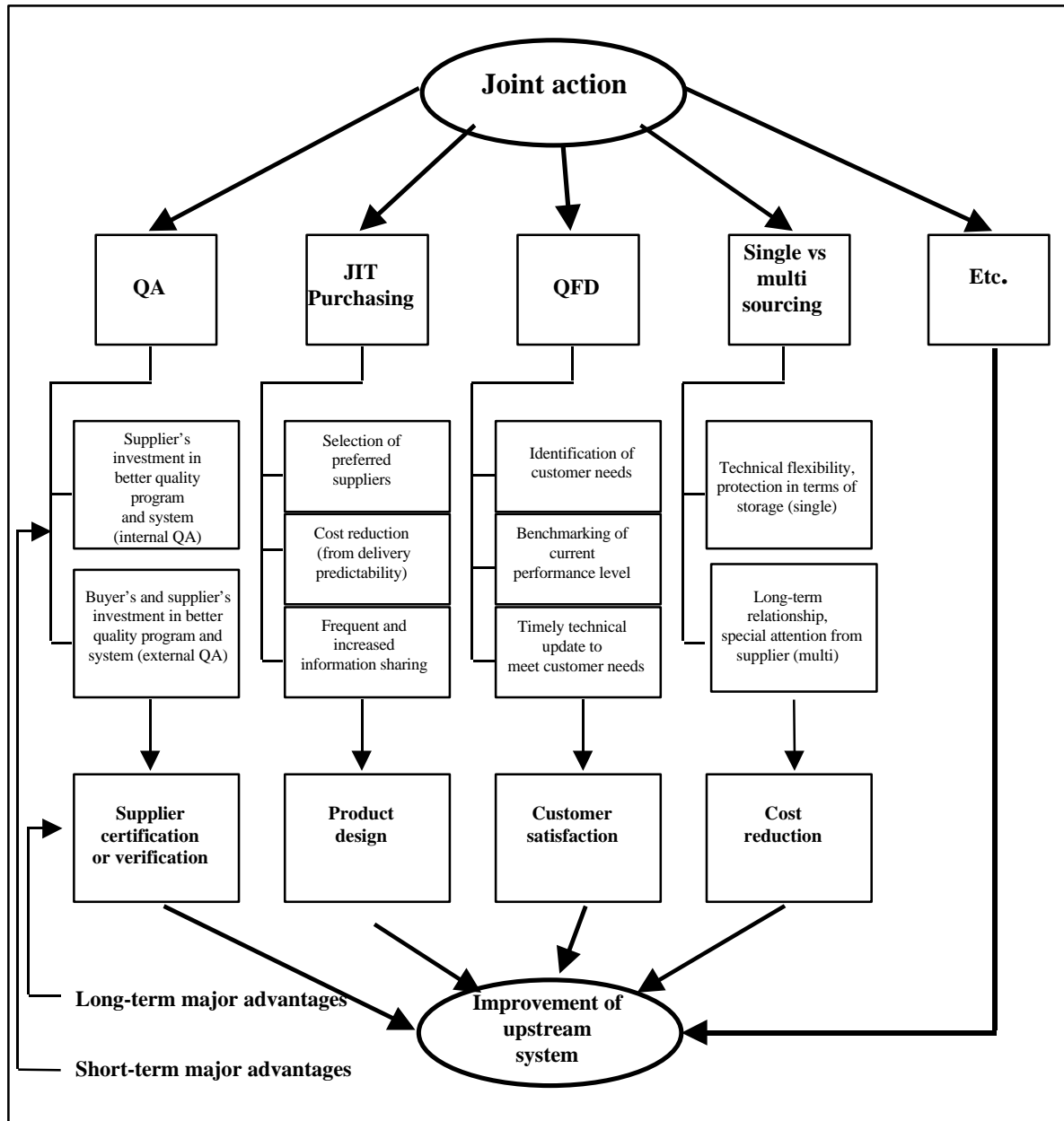
Figure A-4. Conceptual Model for Potential Benefits of Upstream System Joint Action

APPENDIX B. THE U.S. SENATE PRODUCTIVITY AND QUALITY AWARD (SPQA) AND ITS EVALUATION CRITERIA

(All data and information in this section are taken from the application manual for SPQA.)

The award process and the annual SPQA are two of Virginia's most valuable mechanisms for sharing information and knowledge about quality and productivity improvement, and for recognizing exemplary performance. They also enable each organization to obtain valuable insights into how it is currently performing and how it might perform better in the future. The annual award conference is an extremely beneficial educational experience for all who participate, regardless of whether or not an organization applies for the award. The sharing of ideas, philosophies, techniques, strategies and processes involving quality and productivity provides impetus for organizational change and improvement.

B.1   Award Administration

In Virginia, the SPQA (and Award for Continuous Excellence: ACE) are administered and supported by an extensive network of organizations and sponsors. The SPQA Board, comprised of representatives from public and private sector Virginia organizations, and regional quality councils, administers the process. In addition, the Board and the Senators receive ongoing support from Virginia Tech.

B.2   Eligibility

All business, large or small, and all organizations in the public sector are eligible to apply for the SPQA. Applicants may have affiliates, divisions, or head offices in other states; however, the productivity and quality improvement effort under consideration must be implemented within the state of Virginia.

Previous SPQA medallion recipients are eligible to apply for the Award for Continuing Excellence three years after receipt of the medallion.

B.3   *Selection Process*

To be considered for the SPQA (or the ACE), organizations are required to complete and submit the appropriate application. Applications in each category are evaluated and scored by the SPQA Board. Based on the written application, organizations are selected for a site visit. The purpose of the site visit is to gather additional information which confirms that the efforts outlined in the application are indeed taking place within the organization. Finalists are selected following site visits.

B.4   *Background Information*

B.4.1 Categories

There are four categories for this award:

❑   Private sector manufacturing

❑   Private sector service

❑   Public sector state and federal agencies

❑   Public sector local agencies

B.4.2 Awards

There are three levels of recognition that may be awarded in each of the four categories:

❑   U.S. Senate Productivity and Quality Award: Awarded to the outstanding organization(s) in each category. (It is not mandatory to have a medallion recipient in each category.)
❑   U.S. Senate Productivity and Quality Award Plaque: Awarded to the non-medallion finalists in each category.
❑   U.S. Senate Productivity and Quality Award Certificate of Merit: Denotes honorable mention status. The number awarded varies each year.

B.4.3 Criteria

Applications are evaluated based on:

1. Maturity of effort

This dimension assesses the continuity of effort, depth, breadth and age of the effort, quality of methods and approaches. The Board searches for evidence that there is constancy of purpose and that the effort is not a project or quick fix. Organizations are asked to answer questions such as:

♦ When was your organization's improvement effort initiated?
♦ How was the effort conceived?
♦ Is your organization's approach original, or was an existing approach tailored to fit organizational needs?
♦ How extensive is the effort within your company?

2. Top management commitment and involvement (Leadership)

This dimension assesses the level of enlightenment and involvement of top management and leadership in the organization with respect to the quality and productivity improvement system. The Board searches for evidence that top management is doing more than exhorting or paying lip service to the efforts, as well as to confirm that the effort is not overdriven by top management and that it is, in fact, deployed and is a way of doing business. Organizations are asked to answer questions such as:

♦ Describe resource commitments and allocation.
♦ How are the quality values of your organization epitomized by the leader?
♦ What are specific examples of the level of commitment and involvement by top management?

3. Employee involvement, development, and management of participation

This dimension assesses the extent to which the performance improvement effort is deployed at all levels throughout the organization. The Board searches for evidence that the appropriate level of information, knowledge, and power is shared at all levels and that employee ideas and suggestions are treated with respect and are acted upon. Organizations are asked to answer questions such as:

♦ How is employee involvement encouraged by top management?

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♦ What types of quality and productivity training opportunities are provided to employees?
♦ How are teams used?
♦ To what degree are teams empowered?
♦ Are employee development plans derived from quality and company performance plans?

4. Recognition and rewards systems

This dimensions assesses the employee motivation system within the organization. The Board searches for evidence that the recognition and rewards systems are congruent with quality-driven strategies and actions. Organizations are asked to answer questions such as:

♦ To what extent are rewards and recognition systems designed to motivate positive behaviors on the part of all employees?
♦ Does sharing rewards follow sharing of information, knowledge, and power?
♦ How are contributors to and participants in the quality and productivity improvement effort recognized?
♦ Is there an established method for sharing gains?
♦ Who shares in the gains?

5. Plan for continuous improvement

This dimension assesses the extent to which business plans, strategic plans and performance improvement plans are comprehensive and well-integrated. The Board searches for evidence of a systematic performance improvement planning process that is well integrated with strategic and business planning. Organizations are asked to answer questions such as:

♦ How does your organization plan?
♦ Who is involved?
♦ Is there evidence that quality and productivity improvement planning is an integral component of the overall planning system?
♦ How do the quality and productivity efforts integrate with your organization's vision, long-range plans, business plans, and human resource programs?
♦ Are the individuals responsible for implementing these plans involved in developing them?
♦ Are targets, or long-term goals established?
♦ Are self-evaluations made or conducted against other successful efforts?

- Does the process link plans to action?
- How are plans implemented?

6. Performance measurement process

   This dimension assesses the extent to which measurement, data, and information are used to support decision-making at all levels. The Board searches for evidence that employees utilize facts and data and think statistically when solving problems and making decisions. It is recommended that a minimum of 3 years of data be presented to document or substantiate trends. Organizations are asked to answer questions such as:

- To what extent does your organization utilize measurement to support continuous improvement? To what extent does your organization use measurement for purposes of control?
- How do you integrate and ensure congruency of measures with quality strategies and actions? How are measures linked to the overall improvement effort?
- Who "owns" the measurement systems and processes in your organization?
- To what extent are there systematic and ongoing efforts to improve your measurement systems?
- What evidence exists to demonstrate that measurement to support improvement is deployed throughout your organization? How are measures communicated to the organization?
- What type of measures are in place? What, specifically, is measured? How do you determine what to measure?
- Is the quality of the product or service measured at the customer's and supplier's location?
- Is quality measured internally from a customer perspective?
- Is there evidence of statistical thinking?
- Is competitive benchmarking evident?

7. Customer and supplier involvement

   The Board searches for evidence that the organization is managing quality and productivity "totally" by involving suppliers (all upstream systems) as partners in business and by being customer driven. Organizations are asked to answer questions such as:

- How do you involve customers and suppliers in your planning?
- How do your measures reflect focus on suppliers and customers?
- To what extent does your organization show evidence of "appreciation for systems" in your leadership and management?
- How do you assess supplier quality?

♦ How are customers and suppliers involved in your organization's ongoing efforts to improve quality and productivity?
♦ How are customers and suppliers recognized for their efforts?
♦ Is customer satisfaction measured? How?
♦ What use is made of this information?

8. Results over time

This dimension assesses both quantitative and qualitative results. The Board searches for evidence that the organization's quality and productivity efforts are achieving results over time. It is recommended that a minimum of 3 years of data be presented to document or substantiate trends. Organizations are asked to answer questions such as:

♦ Are quality and productivity improvement efforts, in fact, showing results?
♦ What are the specific results from your organization's quality and productivity improvement efforts?
♦ Is it probable that performance will continue to improve or is it stable?
♦ Is there an appropriate balance between short-term, immediate results and longer-term results?
♦ Is there evidence that your organization understands the complex cause and effect relationship between quality and productivity improvement initiatives and results over time?
♦ Is there an appropriate balance between quality of approach and deployment and impact, and results over time?

APPENDIX C. DATA COLLECTION INSTRUMENTS

This Appendix includes:

- Survey Cover Letters,
- Survey instruction sheet,
- Informed consent form,
- Mailed survey questionnaire,
- Focus group guide, and
- Structured interview guide.

The survey was initially developed by the researcher, drawing from the previous literature, and has been revised based on a pilot study and a focus group interview, as well as on graduate advisory committee feedback. The procedures used to develop the mailed survey questionnaire, focus group interview guide, and structured interview guide are explained in-depth in Sections 3.3.1-3.3.2.

COVER LETTER A[*]

Dear <u>Name</u>:

Would you like to know more about what tools and practices are being used in companies like yours to manage customer-supplier relationships? In particular, would you like to know more about what competitor organizations in your industry are doing to improve customer-supplier relationships? As we see frequently in the quality literature, creating customer-supplier partnerships, rather than the traditional adversarial relationships, is increasingly important to improve competitiveness. At Virginia Tech, we are very interested in studying this topic and we ask for your help by completing the enclosed survey on customer-supplier relationships. Your participation in this research effort is very important to provide valuable data from actual companies.

In return for your participation, we will send you a summary of the findings that will benefit you and your company in several ways. In the summary, you'll receive information about:
- what tools and practices competitor organizations are using to create customer-supplier partnerships (we will provide you with a list of 5 or 6 most and least frequently used tools/practices);
- how effectively specific tools/practices have been utilized;
- how specific tools/practices have been internalized; and
- results obtained from improving customer-supplier relationships (improvements in quality, cost, cycle time, etc.).

This information will be extremely valuable in helping your company evaluate its use of customer-supplier tools and practices and identifying improvement opportunities.

We have asked a select group of companies and individuals from marketing, purchasing, and/or production/operations functions to complete the survey. We believe people in these functions have very important perspectives and knowledge to share. While completing the survey, you'll be asked to select one perspective - either as a customer organization (buyer) or as a supplier organization (seller).

Once you have completed the survey, please mail it back to Virginia Tech in the enclosed envelope by <u>survey return date</u>. We will follow-up this letter with a phone call by <u>follow-up date</u> to insure that you've received the survey. If you have any questions or concerns about this research, please contact us (see below).

Thank you in advance for your participation in this important effort and we look forward to providing you with the summary results.

Sincerely yours,

Dr. Eileen Van Aken	Seungho Jung
Assistant Professor	Graduate Research Associate
Industrial & Systems Engineering	Industrial & Systems Engineering
Virginia Tech	Virginia Tech
(Ph) 540-231-2780	(Ph) 540-231-2724
(Email) evanaken@vt.edu	(Email) sjung@vt.edu

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[*] This cover letter was mailed to all 1,811 potential survey respondents.

COVER LETTER B[*]

Jeff Israel, Chairman
Customer-Supplier Division, ASQ
P.O. Box 91178
Portland, Oregon 97291-0178

Dear Customer-Supplier Division Member:

I am writing to ask for your support and participation in the enclosed research study. We feel this is an important project and highly germane to the strategic intent of CSD. The principal researcher (Seungho Jung) is a Doctoral student at Virginia Tech (he is a CSD member as well). Mr. Jung has requested the help of the Customer-Supplier Division because of our memberships' unique experience and qualifications in the areas under investigation.

The purpose of the study is to better understand the tools and practices used to manage and improve customer-supplier relationships, as well as the outcomes of these tools/practices. (See Mr. Jung's cover letter for more information about this research.) The results will not only help evaluate the various tools and practices, but will al help us understand the "best practices" in a customer-supplier environment.

Your participation should benefit you in two ways. First, Mr. Jung has offered to share a summary of his results directly with all respondents. Second, the Division will benefit as well if we can build on the "best practices" findings. As an outcome of this project, I expect the Division will be able to address important publishing and education opportunities (i.e., boo projects, conference topics, workshops, etc.) to help us further the body of knowledge, and better serve our members.

Should you have any questions or concerns about the project, please contact Mr. Jung (540-231-2724), or his advisor (Dr. Eileen Van Aken, 540-231-2780) directly. Thank you in advance for your assistance and participation with this research!

Sincerely,

Jeff T. Israel, Chairman
Customer-Supplier Division, ASQ

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[*] This cover letter was written by Mr. Jeff Israel, Chairman of ASQ-CSD, was sent to 812 ASQ-CSD members only.

SURVEY INSTRUCTIONS

You should have a cover letter, survey instruction (this sheet), Informed Consent Form, and the Customer-Supplier Relationship Survey.

Step 1. Please read the Informed Consent Form and indicate your agreement to participate by signing your name on the second page. [Note that the only procedure which applies to you is 'Mailed Survey.'] Keep Page 3 for your reference should you have questions or concerns.

Step 2. Complete the Customer-Supplier Relationship Survey, answering all questions. The survey includes general questions (Part I) and specific questions about your company's use of tools/practices to manage customer-supplier relationships (Parts II & III).

BEFORE answering any survey questions:

    A. Please select ONE perspective to take in answering questions: either as a supplier company (seller) or as a customer company (buyer). [Question #1 of Part I asks you to indicate which perspective you have selected.] We expect that people in marketing would select a supplier perspective; people in purchasing would select a customer perspective; and people in production or operation may select either perspective.

    B. Please choose only ONE company (not a person or individual) you consider your partner whose administrative and financial structures are independent of your company's. You may use at least one of the following criteria in selecting the partner company: relationships based on win-win scenario or mutual benefit; good two-way communication; long-term view; mentality for total system cost reduction; and/or close, frequent, and continuous business relationship.

Step 3. After completing the survey, please return the Informed Consent Form (Pages 1 & 2) and the survey booklet to us by <u>survey return date</u> using the enclosed self-addressed envelope.

At the end of the survey, you will be asked to provide your name and address *if* you would like to see the results of this survey. Your name and mailing address will be used for this research only, and survey responses will be aggregated for research purposes only. [The code used at the bottom of the survey is only to indicate your company's SIC (Standard Industry Code) number in order to identify industry type.]

Thank you for your participation.

INFORMED CONSENT FORM

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

INFORMED CONSENT FOR PARTICIPANTS OF
INVESTIGATIVE PROJECTS

Title of project: Characteristics and Tools of Effective Customer-Supplier Relationships
Investigators: Seungho Jung & Eileen Van Aken

I.   Purpose of this research

This research is designed to explore more about customer-supplier partnerships, especially the two organizations' joint action and shared results from the joint action.   This research involves managers of buying, selling, and production- or operation-related functions of US-based private manufacturing companies.

II.   Procedures

Three major procedures used in this research are:

Focus group interview
A focus group interview will be conducted with managers of buying, selling, and production- or operation-related functions of companies (ASQ Roanoke-Radford Section members). Primary role of participants in the session is to discuss and share their perceptions about customer-supplier partnerships and other related issues.

Mailed survey
Mailed survey will be administered using 1,811 managers of buying, selling, and production- or operation-related functions of private manufacturing companies in the US to collect quantitative research data.

Structured interviews
Structured interviews will be conducted with managers of buying, selling, and production- or operation-related functions of companies that won Virginia's Senate Productivity and Quality Award in 1990-1996 and members of NAPM and ASQ (Roanoke-Radford Section). Two primary purposes of structured interviews are: first, to collect additional quantitative research data; and second, to collect qualitative research data that will support findings from the mailed survey.

III.   Benefits of this research

For every participant in the above three procedures, a summary result of this research will be shared if he/she expresses his/her willingness to see the results. For participants in the mailed survey and structured interviews, this research will provide them with an opportunity to assess the relationship with their partner in terms of level of joint action and how they share the results of joint action.

IV. Extent of anonymity and confidentiality

Only the research investigators will have access to data, information, and findings of responses from focus group interview, mailed survey, and structured interviews. It is guaranteed that the mailing list will be used for this research only and will be destroyed upon the completion of this research. To guarantee confidentiality, all research procedures are designed and planned so no one is able to identify individual responses.

V. Compensation

There is no monetary compensation involved in this research. Only compensation is sharing of findings of this research -- results, outcomes, and conclusions, etc., and these findings will be shared only if there is a request from the participant.

VI. Freedom to withdraw

All participants are free to withdraw from this research at any time.

VII. Approval of this research

This research project has been approved, as required, by the Institutional Review Board for Research Involving Human Subjects at Virginia Polytechnic Institute and State University and by the Department of Industrial & Systems Engineering.

VIII. Participant's responsibilities

I voluntarily agree to participate in this research.

IX. Participant's permission

I have read and understand the Informed Consent and conditions of this research. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent for participation in this research. If I participate, I may withdraw at any time without penalty. I agree to abide by the rules of this research.

_____   _____
                 Signature   Date

KEEP THIS PAGE FOR YOUR REFERENCE

Should you have any questions about this research or its contents, you may contact:

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VIRGINIA POLYTECHNIC INSTITUTE
AND STATE UNIVERSITY

CUSTOMER-SUPPLIER RELATIONSHIP

SURVEY

Sponsored by

Industrial and Systems Engineering

&

Center for Organizational Performance Improvement

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CUSTOMER–SUPPLIER RELATIONSHIP SURVEY

Please answer all questions, keeping in mind the one perspective you have chosen and the one partner selected to determine your perspective in completing the survey. In this survey, three words or phrases – partner, the other party, and company – are used synonymously to indicate the one company that you have chosen as your partner.

PART I. This part asks for general information about you, your business, and your company that will be used to develop a profile.

I.   I am completing this survey as a major

Customer (Buyer)   ____   Supplier (Seller)   ____   of our partner[*].

(*: Keep in mind that the partner is the most important supplier, or customer, to your company that is characterized by at least one of the following factors: relationships based on win-win scenario or mutual benefit; good two-way communication; long-term view; mentality for total system cost reduction; and close, frequent, and continuous business relationship.)

II. What is your title?

_____ of _____
         (Official Title)   (Name of Department/Division/Section/Etc.)

III. How many years' experience do you have in this job?   _____ Years.

IV. How many years' experience do you have in this organization?   _____ Years.

V. How long has your company been in business with this particular partner? _____ Years.

VI. Please check the category which represents your company's average total annual sales volume.

___ Less than $500,000	___ $500,000 -- 1 million
___ $1 million -- 5 million	___ $5 million -- 10 million
___ $10 million -- 25 million	___ $25 million -- 50 million
___ $50 million -- 75 million	___ $75 million -- 100 million
___ More than $100 million	

VII. What is the total number of employees in your company?

___ Less than 100	___ 100 -- 500	___ 501 -- 1,000
___ 1,001 -- 2,500	___ 2,501 -- 5,000	___ 5,001 -- 10,000
___ 10,001 -- 25,000	___ 25,001 -- 50,000	___ More than 50,000

VIII. Is your facility part of a larger parent organization?

Yes ____   No ____

IX. If you are taking a customer perspective, is this partner the single source supplier for parts or components?   Yes ____   No ____

If you are taking a supplier perspective, is this partner the single source customer purchasing parts or components?   Yes ____   No ____

X. What percentage of sales (if you are the supplier) or purchasing (if you are the customer) are accounted for by this partner?

_____ %.

XI. What is the size of the customer or supplier that you have chosen as your partner in terms of the total number of employees?

___ Less than 100	___ 100 -- 500	___ 501 -- 1,000
___ 1,001 -- 2,500	___ 2,501 -- 5,000	___ 5,001 -- 10,000
___ 10,001 -- 25,000	___ 25,001 -- 50,000	___ More than 50,000

XII. Of all your company's relationship with customers and suppliers, what proportion would you characterize as partnerships?

_____ %.

Please go on to Part II.

1 Strongly Disagree	4 Tend to Agree
2 Disagree	5 Agree
3 Tend to Disagree	6 Strongly Agree

| | **Strongly Disagree** | | | | **Strongly Agree** | |

1. We are using specific tools with the other party to jointly design new products.   1 2 3 4 5 6

2. Any concessions we make to help the other party will even out in the long run.   1 2 3 4 5 6

3. Our procedures for dealing with disputes in the relationship with the partner are informal.   1 2 3 4 5 6

4. Both parties share information on performance in meeting the expectations and needs of the other.   1 2 3 4 5 6

5. The benefits my company realizes from this relationship are proportional to the efforts put forth.   1 2 3 4 5 6

6. The procedures and routines developed by the other party are adapted to our particular situation.   1 2 3 4 5 6

7. The other party is involved in joint planning activities with us that traditionally were considered only one party's responsibility.   1 2 3 4 5 6

8. In the relationship with the other party, there is an exchange of strategic information, such as cost and price structure.   1 2 3 4 5 6

9. We have made financial investments in our company, such as tooling, equipment, and training employees, dedicated to the relationship with the other party.   1 2 3 4 5 6

10. The other party offers specific suggestions to help us improve our processes and procedures.   1 2 3 4 5 6

11. People in the two companies use mechanisms or tools to design better quality systems.   1 2 3 4 5 6

	Strongly Disagree					**Strongly Agree**

12. If our relationship with the other party were discontinued, our sales would suffer. ⟶ 1 2 3 4 5 6

13. The other party is responsive in maintaining a cooperative relationship with us. ⟶ 1 2 3 4 5 6

14. Both parties are committed to improvement that benefits the relationship as a whole, not just the individual parties. ⟶ 1 2 3 4 5 6

15. The relationship with the other party involves the use of quality tools for longer term planning. ⟶ 1 2 3 4 5 6

16. My company, when appropriate, invests money in the other party's facilities and equipment. ⟶ 1 2 3 4 5 6

17. From time to time, we are willing to make sacrifices to help the other party. ⟶ 1 2 3 4 5 6

18. Problems that arise in the course of this relationship are treated as *joint* rather than *individual* responsibilities. ⟶ 1 2 3 4 5 6

19. Our company gets a fair share of the financial rewards and cost savings from the relationship with the other party. ⟶ 1 2 3 4 5 6

20. Benefits from problem solving with the other party are shared jointly. ⟶ 1 2 3 4 5 6

21. Changes in the terms of ongoing transactions with the other party are made if unanticipated economic events occur. ⟶ 1 2 3 4 5 6

22. The relationship with the other party includes formal evaluation and assessment. ⟶ 1 2 3 4 5 6

23. In our relationship, the responsibility for certain tasks has always been assigned to one *or* the other party. ⟶ 1 2 3 4 5 6

24. The other party shares information to help our company increase quality and productivity. ⟶ 1 2 3 4 5 6

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	Strongly Disagree					**Strongly Agree**
25. Both parties have multi-dimensional roles that go beyond the mere buying and selling of products.	1	2	3	4	5	6
26. The relationship with the other party includes diverse expectations over many issues.	1	2	3	4	5	6
27. Each conflict is treated as a further improvement opportunity.	1	2	3	4	5	6
28. If the other party helps us reduce our costs, the other party also benefits.	1	2	3	4	5	6
29. The relationship with the other party can be characterized as flexible.	1	2	3	4	5	6
30. Neither party abuses its power over the other party.	1	2	3	4	5	6
31. The relationship with the other party involves frequent personal contacts for exchange of ideas and information.	1	2	3	4	5	6
32. The other party is flexible in response to requests we make.	1	2	3	4	5	6
33. The other party emphasizes what they will offer in return for our cooperation or participation.	1	2	3	4	5	6
34. There is a strong spirit of fairness in the relationship with the other party.	1	2	3	4	5	6
35. We are willing to put aside contract terms in order to jointly work through difficult technical or quality problems that arise.	1	2	3	4	5	6
36. We keep each other informed about events or changes that may affect the other party.	1	2	3	4	5	6
37. Rather than relying on legal procedures (i.e., filing a suit) to resolve conflicts, both parties rely on more informal means.	1	2	3	4	5	6
38. We provide each other with technical support in substantial detail.	1	2	3	4	5	6

	Strongly Disagree					**Strongly Agree**
39. We regularly provide the other party with long-range forecasts of supply capabilities or demand requirements.	1	2	3	4	5	6
40. We are responsive in maintaining a cooperative relationship with the other party.	1	2	3	4	5	6
41. The other party makes an effort to help us during financial emergencies, for example, deferring payments or paying in advance.	1	2	3	4	5	6
42. Temporary setbacks in the other party's performance commitment are accepted and resolved in an aligned and negotiated way.	1	2	3	4	5	6
43. The other party helps us identify cost reduction opportunities.	1	2	3	4	5	6
44. The relationship could be described as a 'long-term joint venture' or partnership.	1	2	3	4	5	6

Please go on to Part III.

45. In this question, you are asked to do three things. ***First***, check (√) only tools/practices your company is using jointly with your partner. ***Second***, indicate the overall effectiveness of each tool or joint practice you checked by circling the appropriate number. And ***third***, indicate whether or not each tool or joint practice you checked is internalized into the way you and your partner company do business by circling the appropriate number.

(1) TOOLS / JOINT PRACTICES	**(2) LEVEL OF EFFECTIVENESS OF TOOL/PRACTICE USED**	**(3) INTERNALIZATION**
Check tools/practices jointly used with the partner.	*This tool or joint practice has been used very effectively.*	*This tool or joint practice is institutionalized into the way we do business with our partner.*
	1 Strongly Disagree 4 Somewhat Agree 2 Disagree 5 Agree 3 Somewhat Disagree 6 Strongly Agree	
1 Benchmarking	1 2 3 4 5 6	1 2 3 4 5 6
2 Cost of Quality (COQ)	1 2 3 4 5 6	1 2 3 4 5 6
3 Gainsharing	1 2 3 4 5 6	1 2 3 4 5 6
4 Just-In-Time Production and Delivery	1 2 3 4 5 6	1 2 3 4 5 6
5 Quality Circles (QC)	1 2 3 4 5 6	1 2 3 4 5 6
6 Quality Function Deployment (QFD)	1 2 3 4 5 6	1 2 3 4 5 6
7 Statistical Process Control (SPC)	1 2 3 4 5 6	1 2 3 4 5 6
8 Supplier Certification or Verification	1 2 3 4 5 6	1 2 3 4 5 6
9 Joint Quality Education/Training	1 2 3 4 5 6	1 2 3 4 5 6

(1) TOOLS / JOINT PRACTICES	**(2) LEVEL OF EFFECTIVENESS OF TOOL/PRACTICE USED**	**(3) INTERNALIZATION**
Check tools/practices jointly used with the partner.	*This tool or joint practice has been used very effectively.*	*This tool or joint practice is institutionalized into the way we do business with our partner.*

1 Strongly Disagree   4 Somewhat Agree
2 Disagree   5 Agree
3 Somewhat Disagree   6 Strongly Agree

10	Joint Problem-Solving Teams	1 2 3 4 5 6	1 2 3 4 5 6
11	Joint Planning	1 2 3 4 5 6	1 2 3 4 5 6
12	Exchange of Strategic Information	1 2 3 4 5 6	1 2 3 4 5 6
13	Quality Audit	1 2 3 4 5 6	1 2 3 4 5 6
14	Joint Investment on R & D	1 2 3 4 5 6	1 2 3 4 5 6
15	In-plant Representative	1 2 3 4 5 6	1 2 3 4 5 6
16	Supplier or Customer Performance Measurement System	1 2 3 4 5 6	1 2 3 4 5 6
17	ISO 9000 and/or QS 9000 and/or Baldrige Criteria	1 2 3 4 5 6	1 2 3 4 5 6
18	Dynamic Control Tools: e.g., flow diagram and FMEA (failure mode and effect analysis)	1 2 3 4 5 6	1 2 3 4 5 6

46. Please list below any additional tools/practices not listed in Question #45 that you and your partner company are using jointly.

(1) TOOLS / JOINT PRACTICES

Specify tools/practices jointly used with the partner.

(2) LEVEL OF EFFECTIVENESS OF TOOL/PRACTICE USED

This tool or joint practice has been used very effectively.

(3) INTERNALIZATION

This tool or joint practice is institutionalized into the way we do business with our partner.

1 Strongly Disagree   4 Somewhat Agree
2 Disagree   5 Agree
3 Somewhat Disagree   6 Strongly Agree

19		1 2 3 4 5 6	1 2 3 4 5 6
20		1 2 3 4 5 6	1 2 3 4 5 6
21		1 2 3 4 5 6	1 2 3 4 5 6
22		1 2 3 4 5 6	1 2 3 4 5 6
23		1 2 3 4 5 6	1 2 3 4 5 6

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47. *First*, identify the impact of using tools or joint practices by specifying a *percentage increase* or *decrease*. *Second*, identify only tools/practices in the last column that are predominantly responsible for the percentage increase/decrease in quality, cost, cycle time, and other performance dimensions. (Some tools/joint practices may appear more than once.)

PERFORMANCE DIMENSIONS	IMPACTS		TOOLS/JOINT PRACTICES
	Specify Percentage	*+: Increase -: Decrease*	*(Either specify tools and joint practices or use numbers from Questions #45 and 46)*
Quality of products	%	+ / -	
Costs	%	+ / -	
Cycle time	%	+ / -	
Other performance dimensions (Please specify)			
(1)	%	+ / -	
(2)	%	+ / -	
(3)	%	+ / -	

48. Based on all the tools/joint practices you identified in Questions #45 & 46, what is the *overall* effect on organizational performance? (Please specify a percentage increase or decrease.)

Specify   *Check only one*

_____ %   Increase [ ] / Decrease [ ]

	Strongly Disagree					Strongly Agree

1 Strongly Disagree   4 Somewhat Agree
2 Disagree   5 Agree
3 Somewhat Disagree   6 Strongly Agree

	Strongly Disagree					Strongly Agree
49. Overall, my level of satisfaction with this partner is very high.	1	2	3	4	5	6
50. Overall, the quality of the partnership with this partner is very high.	1	2	3	4	5	6

Thank you for responding to this survey.
Please return the survey using the envelope provided,

or mail it TO (in case you lose the envelope):

Seungho Jung
1900 Kraft Drive, Suite 200
Center for Organizational Performance Improvement
Blacksburg, VA 24060

If you would like to see a summary result of this study, please mark here [   ] and provide your name and address below.

Name: _____

Organization: _____

Mailing Address: _____

_____

e-mail address: _____

FOCUS GROUP INTERVIEW GUIDE

Who, where, and when

Moderator: Dr. Eileen M. Van Aken
Recorder: Seungho Jung
Participants:
Place:
Date and time:

Introductory comments

Introduction and greetings
Good afternoon and thank you for taking the time to join our group session today. My
name is Eileen Van Aken, an assistant professor of the Industrial & Systems Engineering
department at Virginia Tech. Assisting me is Seungho Jung, a Ph.D. candidate in ISE at
Virginia Tech. We have invited you to share and discuss your perceptions and opinions
on customer-supplier relationships. We expect the session to last no longer than an hour
and a half. If anyone needs to leave earlier, that's fine.

Purpose of meting
The purpose of this group session is to explore more about customer-supplier partnerships
and what we call joint action by capturing your expertise and perceptions through
discussion and information sharing. We are especially interested in key factors and
characteristics of customer-supplier partnerships and the results obtained from these types
of partnerships.

How we will use the outcomes of this group session
We will use all data and information we will share today to develop a survey instrument
that Seungho will use in his research as his major data collection instrument. We
recognize the importance of maintaining confidentiality of what you say today - none of
the responses from this session will be attributed to individuals by name.

Ground rules and moderator's role
We have prepared some ground rules for this session that we'd like you to use:
- It's okay for us to get off-track - I will raise questions I'd like to have the group
  explore. At any point, we can go back to an earlier question. And, you can bring up

your own issues to discuss, even if they seem unrelated to what we've already talked about. It's okay if you get off on other topics, but if we seem to get off track too far or too long, I'll bring us back to our topic.

- Be open and honest - Nothing you say will be attributed to you. I would like everyone to feel comfortable sharing both positive and negative comments.
- Dialogue - I would like to create a dialogue when you all talk with each other about the issues, rather than talking to me as the moderator. Also, I encourage you to share your point of view, even if it differs from what someone else has said.
- Lastly, it's helpful if only one person talks at a time so we can capture what you say.

Before we start, I would like to inform you of two things:
1. First, we would like to audio tape this session to ensure we don't lose any important information. Does anyone have any objections to this? *(pause);*
2. Second, as part of research protocol for Virginia Tech, we need you to read the Informed Consent Form. After reading, please sign at the bottom to indicate your agreement to participate in the research. The paragraphs about the mailed survey and structured interviews do not relate to you - only the information about focus group interviews does. The third page is for you to keep in case you have questions or concerns about the research, so please tear that off.

Questions

Opening question
1. Although we can see everyone's name on your nametag, we do not know other information such as your company and function. Please take less than a minute and tell us about you: your name, your company (service/manufacturing.), your official title, and your primary role in your company, whether your experience is more from a supplier perspective or customer perspective or both.

Introductory questions
2. Based on your experience, what differences have you observed in customer-supplier relationships between now and 5 or 10 years ago?

Transition comments and question
3. As we've said, today's discussion focuses on customer-supplier partnerships. How would you define or describe the word 'partnership' with a customer or supplier as compared to the traditional customer-supplier relationship? In other words, what factors do you think characterize a partnership? *(if necessary, provide some examples*

such as exchange of strategic information, level of mutual dependency, and frequency of personal contacts; use probe and pause to obtain as many factors and examples as possible)

4. To what extent does your company have a true partnership with your customers or suppliers? Do you have a partnership more with customers OR with suppliers? Why?

Key questions
Among the factors you have just mentioned, many people have identified 'joint action' as one of the contributing factors to good customer-supplier partnerships. We define joint action as the interpenetration of organizational boundaries, which include both using specific tools like quality audits, Just-In-Time purchasing and delivery, etc., and other practices like joint problem-solving teams or sharing cost information to help the partner improve quality, productivity, etc.

5-1.   What specific tools or other joint practices have you or your company used in working with customers and suppliers?

5-2.   How did you identify the tools and other joint practices? (identified by your company or by partner?)

5-3.   How were the tools and other joint practices implemented?

6. In terms of the roles or expectations of your company and your partner company, what changes or differences have you noticed in the relationship with your partner in the last 10 years?

Now, I'd like to have us talk about the results and outcomes of tools/practices we've been talking about.
Considering the efforts to improve customer-supplier partnership using tools and joint practices,

7-1.   What types of benefits have arisen?

7-3.   What have been the costs? The downside?

7-3.   Has it been worth the effort?

8-1.   What are conflicts that arise (like delivery performance, not meeting agreements/time commitments, quality problems, etc.)

8-2.   When conflicts or problems arise with customers or suppliers, what happens? How is conflict resolved? *(if necessary, say this: Do you rely on formal channels that*

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include strictly business-related procedures, or sometimes, lawsuits, other than informal channels?)

9. One source of conflict can be sudden changes in operations with your partner such as changes in delivery schedules, supply/demand requirements, and other external business environments. How have you reacted to these kinds of sudden changes? In other words, how would you describe the level of flexibility in the relationship with your partner? What do you think about your partner's level of flexibility?

From joint action with a customer or supplier, benefits may result from cost savings or other improvements made. Examples are benefits from reduced delivery costs which are possible by Just-In-Time purchasing or delivery.

10. In general, how are these benefits "shared" among your company and partner? Are they distributed fairly or equitably? Do you think your company has been getting at least a fair share of rewards and cost savings from joint action?

11. Overall, what are the biggest challenges and issues you see in managing and improving customer-supplier relationships in the future?

Ending question
12. Assume you are now talking to the individual with whom you have maintained the closest business partnerships for years. What would you like to discuss with him/her to further improve the relationship with the individual and the company he/she is working for?

13. Lastly, have we missed anything? *(if time permits; pause)*

Wrap-up

Thank you very much for your time. If you would like, we will share with you a summary of today's discussion. Leave a card if you are interested.

STRUCTURED INTERVIEW GUIDE

Interviewee:
Date:
Start time:
End time:

Introductory comments
Thank you for taking time to participate in my research, especially in this interview.
Today, I'd like to ask some questions about: first, customer-supplier partnerships; second, customer-supplier joint action; and last, other related issues.
All you will say today is strictly confidential and will be used for this research only. If you have any questions or concerns about my research and this interview, feel free to call me or e-mail me.
I need to ask questions in the way they are phrased in this interview guide. If you do not understand or cannot hear the questions, please tell me, I will repeat them. I am expecting this interview to last about an hour.
Before we start, I would like to tape record our conversation. Do you have any objections to it?
(pause; if necessary, replace tape recording with handwriting.)

Background information about the interviewee and the company
(Use the survey the interviewee already completed before the interview.)
Since you already completed the survey, I will not go deeper into specifics about you and your company. Questions and your responses in this section will be used to produce respondents' profile.

1. First, tell me what your company is manufacturing. (if necessary, ask this question: What is your company's SIC number?)

2. You indicated in this survey that your official title is _____. Could you give me a more detailed job description of your work (1) in general and (2) in the relationship with your major partner? (if necessary, tell/show the interviewee his/her previous response regarding his/her major partner -- either individual or company, or both.)

3. *(This question applies to only people whose answer to the 4th question of Part I of survey is 'no' - the partner is not a single source.)* Other than the partner you thought about in completing this survey, how many other sources do you have that your company has the same or similar business relationships?

Partnerships
Now, let's talk about the partnerships.

4. How would you describe the word 'partnership'? In other words, what factors do think are the most important ones contributing to the relationship with your partner?

5. Are you satisfied with the relationship with your partner? (*If 'yes', go on to the next question; if 'no', why do you think so?*)

6. You indicated that you completed the survey as customer/supplier *(choose one).* Could you give me some information about your partner? -- who they are, what they buy from/sell to your company, etc.

Joint action & its effectiveness

Among the factors you have just mentioned, many people have identified 'joint action' as one of the contributing factors to good customer-supplier partnerships. We define joint action as the interpenetration of organizational boundaries, which include both using specific tools like quality audits, Just-In-Time purchasing and delivery, etc., and other practices like joint problem-solving teams or sharing cost information to help the partner improve quality, productivity, etc.

7. Could you give me some examples of joint action that your and your partner companies have used jointly? *(if necessary, say this: Answer this question in terms of specific tools and other joint practices your and your partner companies have used.)*

8. Are tools and joint practices in general used jointly or more by one party than the other? If they are used more by one party, which and why?

9. Among the tools and joint practices we are talking about, based on your experience, what tools and joint practices have been used mostly effectively?

10. And what tools and joint practices have been used least effectively? Why?

11. Do you have other tools and joint practices that you plan to use in the near future in the relationship with your partner? If yes, what are they?

12. Are you using exemplary tools and joint practices that other companies are using such as Baldrige winners and ISO 9000 standards? If yes, what are those companies and which of their tools and joint practices are you interested in?

13. If you have experienced roadblocks/barriers in using tools and joint practices in the relationship with your partner, what are they?

Shared results

14. In terms of the roles of your and your partner companies', what changes or differences have you noticed as a result of the joint action we just talked about?

15. Could you give me specific performance improvements resulting from the partnerships or joint action?

16. Joint action in the relationship with your partner means there are more frequent and intensive interactions between your and your partner companies. When conflicts or problems arise with customers or suppliers, what happens? How is conflict resolved? *(if necessary, say this: Do you*

rely on formal channels that include strictly business-related procedures, or sometimes, lawsuits, other than informal channels?)

17. One source of conflict can be sudden changes in operations with your partner such as changes in delivery schedules, supply/demand, and other external business environments. How have you reacted to these kinds of sudden changes? In other words, how would you describe the level of flexibility that you and your company have showen in the relationship with your partner? What do you think about your partner's level of flexibility?

18. In general, how would you share or divide costs and benefits resulting from the joint action with your partner? Are they divided fairly? Do you think your company has been getting at least a fair share of rewards and cost savings from joint action?

19. Overall, to what extent do you think your joint action with your partner is achieving the planned goals?

Other issues
20. What specific trends are you expecting to happen
    - in the relationship with your partner?
    - in customer-supplier relationships in general?

21. Assume you are now talking to the individual with whom you have maintained the closest business partnerships for years. What would you like to discuss with him/her to further improve the relationship with the individual and the company he/she is working for?

22. Is there anything that I have missed or not asked that I need to know to understand customer-supplier relationships?

Wrap-up
Thank you very much for you time. I will share with you the result of today's interview and you can add or change anything. I will also share overall study results if you are interested.

APPENDIX D. PILOT RESULTS AND CHANGES IN THE MAILED SURVEY QUESTIONNAIRE

D1. RESULTS FROM THE PILOT STUDY AND SUBSEQUENT CHANGES IN THE MAILED SURVEY QUESTIONNAIRE

D2. RESULTS FROM THE FOCUS GROUP INTERVIEW AND PILOT STRUCTURED INTERVIEWS AND SUBSEQUENT CHANGES IN THE MAILED SURVEY QUESTIONNAIRE

D1. RESULTS FROM THE PILOT STUDY AND SUBSEQUENT CHANGES IN THE MAILED SURVEY QUESTIONNAIRE

❑ Potential participants: 46 managers of previous SPQA applicant companies.

❑ Number of actual participants: 11

❑ Response rate: 21.7% (10/46)

❑ Summary profile of participants

Name	Organization	Title	Job Tenure
Fraley, J.	Print Inc.- Rampart Packaging Division	General Manager	12
Meyerhoeffer, D. N.	ComSonics, Inc.	Director of Operations	8
Roth, A.	Cookson Fibers, Inc.	President	4
Senecal, C.	Cannon VA, Inc.	Sr. Director, Manufacturing/Production & Materials Control	6
Stalls, J.	Perdue Farm Emporia Plant	Plant Manager	2
Wade, H. E.	ComSonic, Inc.	Marketing & Communication	3
Krall, G.	Sara Lee Knit Products	Purchasing Director	7
Anonymous		Plant Manager	4
Anonymous		Manager, Purchasing	6
Anonymous		Director, Purchasing	5

□ Result 1: Correlation coefficients

```
                    The SAS System          21:50 Tuesday, April 8, 1997    1

Joint use of tools:                         TQMT
Joint practices:                            PRAC
Role integrity with financial impacts:      RIW
Role integrity without financial impacts    RIWO
Conflict resolution:                        CR
Flexibility:                                FLEX
Mutuality with financial impacts:           MUW
Mutuality without financial impacts:        MUWO
```

OBS	TQMT	PRAC	RIW	RIWO	CR	FLEX	MUW	MUWO
1	5.75	5.33333	4.55556	5.8	4.57143	5.9	5.625	6.0
2	3.50	3.50000	3.00000	4.0	4.00000	4.6	4.000	4.0
3	5.25	4.66667	4.88889	4.9	4.28571	5.0	5.125	5.0
4	3.50	3.66667	3.77778	4.0	4.00000	4.0	4.000	4.5
5	4.25	3.50000	4.22222	3.7	4.00000	3.8	2.250	2.0
6	5.50	4.83333	4.88889	5.4	5.28571	5.0	4.625	5.5
7	5.50	4.33333	4.44444	4.9	5.00000	4.6	5.000	5.5
8	5.25	4.83333	4.33333	5.2	4.85714	4.1	4.875	6.0
9	5.25	4.33333	4.44444	5.1	4.57143	4.9	5.125	5.0
10	4.75	4.00000	3.77778	4.8	4.57143	4.7	4.875	5.0

```
                            Correlation Analysis

    8 'VAR' Variables:   TQMT    PRAC    RIW     RIWO    CR      FLEX    MUW     MUWO

        Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0 / N = 10
```

	TQMT	PRAC	RIW	RIWO	CR	FLEX	MUW	MUWO
TQMT	1.00000							
PRAC	0.88173	1.00000						
RIW	0.83182	0.73956	1.00000					
RIWO	0.89342	0.95387	0.64581	1.00000				
CR	0.78914	0.67981	0.58962	0.76645	1.00000			
FLEX	0.61707	0.70989	0.37797	0.76834	0.35235	1.00000		
MUW	0.66905	0.76371	0.37015	0.85304	0.55296	0.74439	1.00000	
MUWO	0.65800	0.80546	0.38345	0.86629	0.70324	0.58738	0.93021	1.00000

```
                              Simple Statistics
```

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
TQMT	10	4.850000	0.826640	48.500000	3.500000	5.750000
PRAC	10	4.300000	0.627556	43.000000	3.500000	5.333333
RIW	10	4.233333	0.577231	42.333333	3.000000	4.888889
RIWO	10	4.780000	0.676264	47.800000	3.700000	5.800000
CR	10	4.514286	0.447720	45.142857	4.000000	5.285714
FLEX	10	4.660000	0.607728	46.600000	3.800000	5.900000
MUW	10	4.550000	0.950512	45.500000	2.250000	5.625000
MUWO	10	4.850000	1.179689	48.500000	2.000000	6.000000

❑ Result 2: Internal-consistency reliability

```
The SAS System        22:24 Tuesday, April 8, 1997    1

ALPTQMT
                                0.6300813
ALPPRAC
                                0.6008359

ALPRIW
                                0.6587073

ALPRIWO
                                0.8870532

ALPCR
                                0.0955254**

ALPFLEX
                                0.8637518

ALPMUW
                                0.9300538

ALPMUWO
                                0.5322688
```

***: See next section for correlational coefficients of 7 items in CR (Conflict Resolution).

❑ Result 3: Correlational coefficients of 7 items in CR (Conflict resolution)

Because the value of reliability coefficient (α) of conflict resolution was too low, correlational coefficients of items in this indicator was examined before taking any actions such as deleting/adding items or making changes in wordings.

```
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              OBS    C1    C2    C3    C4    C5    C6    C7
               1      6     2     6     6     5     1     6
               2      4     4     4     4     4     4     4
               3      5     4     4     5     2     5     5
               4      3     4     4     4     5     4     4
               5      2     5     2     4     5     5     5
               6      5     5     5     6     5     6     5
               7      4     5     5     6     4     6     5
               8      6     6     5     4     2     6     5
               9      4     3     4     5     5     5     6
              10      4     5     5     5     4     4     5
```

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                              Correlation Analysis

          7 'VAR' Variables:  C1       C2       C3       C4       C5       C6       C7

             Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0 / N = 10

                  C1           C2          C3           C4           C5          C6          C7

    C1      1.00000
    C2     -0.14546      1.00000
    C3      0.80928     -0.19612     1.00000
    C4      0.43595     -0.29549     0.63746     1.00000
    C5     -0.46713     -0.42422    -0.12087     0.22259     1.00000
    C6     -0.16509      0.77652    -0.30208    -0.11800    -0.34521     1.00000
    C7      0.39947     -0.43122     0.31009     0.57104     0.13921    -0.22140     1.00000
                                      Simple Statistics
     Variable       N         Mean        Std Dev          Sum        Minimum      Maximum

      C1           10       4.300000     1.251666      43.000000     2.000000     6.000000
      C2           10       4.300000     1.159502      43.000000     2.000000     6.000000
      C3           10       4.400000     1.074968      44.000000     2.000000     6.000000
      C4           10       4.900000     0.875595      49.000000     4.000000     6.000000
      C5           10       4.100000     1.197219      41.000000     2.000000     5.000000
      C6           10       4.600000     1.505545      46.000000     1.000000     6.000000
      C7           10       5.000000     0.666667      50.000000     4.000000     6.000000
```

As shown in the result above, some correlational coefficients were very low. Low
correlations indicate the item was not related to the other items in the scale. In other
words, the item did not measure the same thing the other items were measuring.
However, because the sample size of the pilot study was only 10, it was difficult to take
any actions, e.g., deleting/adding items or making changes in some items' wordings, based
on the pilot results. In the next section, some changes in the mailed survey questionnaire
are summarized that were made before conducting a focus group interview and three
structured interviews.

❑ **Changes in the mailed survey questionnaire**

All changes summarized in this section were made after the pilot study and before the
focus group interview and structured interviews. Because there were several rounds of

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revisions (deleting/adding and changing), only original items used in the pilot study and revised items are shown with respect to type of changes.

Variables and Indicators	Original Items	Type of Changes	Revised Items
Organizations and individual demographics Items: Part I (9 items)	# I, II, III, IV, V, VII, VIII, IX	No change Added	# I, II, III, IV, V, VII, VIII, IX # VI, X, XI, XII
q1-q3 joint action (Independent variable)			
Joint use of tools Items: Part II (1, 11, 15)	We are using specific TQM tools, such as QFD and benchmarking, to jointly design new products.	Changes in wording	1. With our partner, we are using specific tools to jointly design new products.
	To design better quality control systems, managers of the two companies use not only personal contacts but also certain mechanisms or tools to share information with each other.	Changes in wording	11. People in the two companies use mechanisms or tools to design better quality systems.
	Our relationship implies joint deployment and implementation of specific TQM tools on both short- and long-term planning horizons.	Changes in wording	15. The relationship involves the use of specific quality tools for long-term planning.
	Our agreements with the partner include formal evaluation programs and follow-up reports on their performance in relation to us.	Moved to 'Joint practice'	
Joint practices Items: Part II (7, 8, 22, 23, 31, 35, 44)	In our relationship, organizational boundaries become penetrated by the integration of goals and objectives as our partner becomes involved in planning activities that traditionally were considered our responsibility.	Changes in wording	7. Our partner is involved in joint planning activities with us that traditionally were considered only one party's responsibility
	Our relationship implies an exchange of strategic information, such as cost and price structure.	Changes in wording	8. In the relationship with our partner, there is an exchange of strategic information, such as cost and price structure.
		Added with changes in wording	22. The relationship with our partner includes formal evaluation programs and follow-up reports.

Variables and Indicators	Original Items	Type of Changes	Revised Items
Joint practices (cont.)	In our relationship, the responsibility for certain tasks has always been assigned to one *or* the other party.	No change	23. In our relationship, the responsibility for certain tasks has always been assigned to one *or* the other party.
	Our relationship represents two parties carrying the focal activities in cooperated or coordinated way through frequent personal contacts and exchanges of idea.	Deleted and added	31. The relationship with our partner involves frequent personal contacts for exchange of ideas and information.
	We are willing to put aside contract terms in order to work through difficult problems raised by each other.	Changes in wording	35. We are willing to put aside contract terms in order to jointly work through difficult technical or quality problems that arise.
	Our relationship with our partner could be described as a "long-term joint venture' rather than a 'series of one shots, entered into one at a time.'	Changes in wording	44. The relationship could be described as a 'long-term joint venture" or partnership.
Shared results (Dependent variables)			
Role integrity with financial impacts Items: Part II (9, 12, 16, 24, 38, 41, 43,)	We have made a significant investment in tooling and equipment dedicated to our relationship with our partner; We have made significant investments in displays, trained sales people, etc. Dedicated to our relationship with the partner.	Combined with changes in wording	9. We have made financial investments in our company, such as tooling, equipment, and training employees, dedicated to the relationship with our partner.
	If our relationship were discontinued with our partner, our sales would suffer.	Change in wording	12. If our relationship with our partner were discontinued, our sales would suffer.
	Our company, when appropriate, invests some money in our partner's facilities and equipment.	Changes in wording	16. My company, when appropriate, invests money in our partner's facilities and equipment.
	We expect our partner to share any information which would help our company increase quality and productivity.	No change	24. We expect our partner to share any information which would help our company increase quality and productivity.
	We provide each other with technical documentation in substantial detail to increase our market share.	Changes in wording	38. We provide each other with technical support in substantial detail.
	Our partner makes an effort to help us during financial emergencies.	Changes in wording	41. Our partner makes an effort to help us during financial emergencies, for example, deferring payments or paying in advance.

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Variables and Indicators	Original Items	Type of Changes	Revised Items
Role integrity with financial impacts (cont.)	Our partner helps us in value analysis ideas, cost reductions, problem solving, etc.	Changes in wording	43. Our partner helps us identify cost reduction opportunities.
	Our partner offers specific suggestions for us to make changes in marketing and/or operating procedures.	Moved to 'Role integrity without financial impacts'	
Role integrity without financial impacts		Added	4. Both parties share information on performance in meeting the expectations and needs of the other.
Items: Part II (4, 10, 13, 17, 25, 26, 36, 39, 40, 45)		Added with changes in wording	10. Our partner offers specific suggestions to help us in improving our marketing and/or operating procedures.
	Our partner is very conscientious, responsive, and resourceful in maintaining a cooperative relationship with us.	Changes in wording	13. Our partner is responsive in maintaining a cooperative relationship with us.
	From time to time, we are willing to make sacrifices to help our partner.	No changes	17. From time to time, we are willing to make sacrifices to help our partner.
	There are many expectations between the two companies which go beyond the mere buying and selling of products.	Changes in wording	25. Both parties have multi-dimensional roles that go beyond the mere buying and selling of products.
	The exchange relationship with the other party creates a complex web of expectations with us over all kinds of issues.	Changes in wording	26. The relationship with our partner includes diverse expectations over many issues.
	It is expected we keep each other informed about events or changes that may affect the other party.	Changes in wording	36. We keep each other informed about events or changes that may affect the other party.
	We regularly provide our partner with long-range forecasts of supply/demand requirements.	Changes in wording	39. We regularly provide our partner with long-range forecasts of supply capabilities or demand requirements.
	We are very conscientious, responsive, and resourceful in maintaining a cooperative relationship with our partner.	Changes in wording	40. We are responsive in maintaining a cooperative relationship with our partner.
		Added	45. Our partner shares the responsibility for market share of our products.

Variables and Indicators	Original Items	Type of Changes	Revised Items
Role integrity without financial impacts (cont.)	In our relationship, our partner is expected, and sometimes, required, to share the responsibility for designing and developing new parts and components; We advise the partner of its performance in relation to that of other partners; Exchange of information in this relationship takes place frequently and informally.	Deleted	
Conflict resolution Items: Part II (3, 18, 27, 30, 37, 42)	Our company's procedures for dealing with disputes in the relationship with the partner are informal.	Changes in wording	3. Our procedures for dealing with conflicts in the relationship with the partner are informal.
	Problems that arise in the course of this relationship are treated as joint rather than individual responsibilities.	No change	18. Problems that arise in the course of this relationship are treated as joint rather than individual responsibilities.
	It is expected that each dispute should be treated on its individual merits.	Changes in wording	27. Each dispute is treated as further improvement opportunity.
	It is expected that each party should limit its use of power it has over the other party.	Changes in wording	30. Neither party abuses its power over the other party.
	It is expected if certain pre-specified events occur, no suit should automatically be filed by one or the other party.		37. No suit is filed by either party if unexpected events occur.
	Even though the performance of our partner directly relates to our company's immediate goals, temporary setbacks in their partner's performance is accepted and solved in a aligned and negotiated way.	Changes in wording	42. Temporary setbacks in our partner's performance commitment are accepted and resolved in an aligned and negotiated way.
	Our partner's problems are our problems	Deleted	
Flexibility Items: Part II (6, 21, 29, 32)	The procedures and routines developed by our partner, as part of their relationship with us, are tailored to our particular situation.	Changes in wording	6. The procedures and routines developed by our partner are adapted to our particular situation.
	The modifications of the terms of ongoing transactions to reflect changing economic circumstances are expected; It is expected that changes in the terms of ongoing transactions would be allowed if unanticipated events occur.	Combined	21. Changes in the terms of ongoing transactions with our partner are made if unanticipated economic events occur.

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Variables and Indicators	Original Items	Type of Changes	Revised Items
Flexibility (cont.)		Added	29. The relationship with our partner can be described as flexible.
	Our partner is flexible in response to requests we make.	No change	32. Our partner is flexible in response to requests we make.
	Our company has some unusual technical standards and norms that have required extensive adaptation by our partner; The ability to react to a changing environment is provided by a flexible exchange relationship; Our relationship is characterized by willingness to make adjustments to contracts with the partner in the face of problems or special circumstances; We are apt to rework agreements with the partner when unforeseen supply/demand or market disturbances arise.	Deleted	
Mutuality with financial impacts	Any concessions we make to help our partner will even out in the long run.	No change	2. Any concessions we make to help our partner will even out in the long run.
Items: Part II (2, 5, 19, 20, 28, 33)	Our benefits from this relationship are generally proportional to our level of input on cooperative efforts with our partner.	Changes in wording	5. The benefits my company realizes from this relationship are proportional to the efforts put forth.
	Our company gets at least a fair share of the rewards and cost savings from the relationship with our partner.	Changes in wording	19. Our company gets a fair share of financial rewards and cost savings from the relationship with our partner.
	The benefits from problem solving with our partner are always shared jointly.	Changes in wording	20. Benefits from problem solving with our partner are shared jointly.
	If our partner helps us reduce our cost, the partner also directly benefits.	Changes in wording	28. If our partner helps us reduce our cost, the partner also benefits.
	Our partner emphasizes what they will offer in return for our cooperation or participation when presenting certain ideas for future joint action.	Changes in wording	33. Our partner emphasizes what they will offer in return for our cooperation or participation.
	Sometimes our company absorb some costs we could share with the partner; Sometimes our partner eats some expenses we may have caused.	Deleted	

Variables and Indicators	Original Items	Type of Changes	Revised Items
Mutuality with financial impacts Items: Part II (14, 34)	Both parties are committed to improvement that benefits the relationship as a whole, not just the individual parties.	No change	14. Both parties are committed to improvement that benefits the relationship as a whole, not just the individual parties.
	Expectations of contractual relationships reflect the strong spirit of fairness which exists in the exchange relationship.	Changes in wording	34. There is a strong spirit of fairness in the relationship with our partner.
Tools and joint practices used and their effectiveness Items: Part IV (46 and 47)	Added: 6-point effectiveness scales (ordinal).		

D2. RESULTS FROM THE FOCUS GROUP INTERVIEW AND PILOT STRUCTURED INTERVIEWS AND SUBSEQUENT CHANGES IN THE MAILED SURVEY QUESTIONNAIRE

Except for the changes made in the mailed survey questionnaire based on the pilot study results, additional changes, or improvements, were made in the mailed survey questionnaire after conducting the focus group interview and pilot structured interviews. This section introduces summary results of the focus group interview and three preliminary structured interviews, followed by additional changes in the mailed survey questionnaire.

❑ **Combined summary results from the focus group interview and pilot structured interviews**

This following report was prepared at the conclusion of the focus group session and three one-on-one preliminary structured interviews conducted as follows:

Focus group session

Moderator: Dr. Eileen Van Aken
Recorder: Seungho Jung
Date: 02/12/1997 (4:30--6:00 PM)
Attendees: Steve Thelen, Sr. Quality Manager, Lynchburg Foundry Co.
                 Jeff Copeland, Director of Quality, Tele-Path Instruments
                 L. Jeannie Baker, VT-Student health services

Pilot structured interviews

Interviewer: Seungho Jung
Interviewees:
     Dianne Mendleson, Senior Buyer, VT-Southgate center (02/28/1997)
     Lori Nelson-Chinn, VCO, VT-Southgate center (03/03/1997)
     Michele Meyer, Training administrator, Federal Mogul Co. (03/13/1997)

This report is a shortened summary designed to be shared with participants of both the focus group session and the pilot structured interviews and was transcribed from tape-recorded conversations.

Purpose

The purpose of focus group session and pilot structured interviews was to explore more about customer-supplier partnerships and what we call joint action by capturing practitioners' expertise and perceptions through discussion/information sharing/one-on-one interviews. Findings from the focus group session and the pilot structured interviews were used to develop a survey questionnaire that will be used to obtain data on the same topic from a much larger group of individuals.

Description of the study

At Virginia Tech, a research is conducted by a team of professor – Dr. Eileen Van Aken of Industrial & Systems Engineering – and Ph.D. candidate – Seungho Jung of Industrial & Systems Engineering. The research is about customer-supplier partnerships, joint action, and shared results from the joint action. The major focus is on key factors and characteristics of customer-supplier partnerships, and the results obtained from these types of partnerships. In order to improve the quality of the research and focus it more closely on issues and problems faced by practitioners, a focus group session and three structured interviews were conducted, as described earlier. The purpose of the study is to develop a better understanding of the tools and practices used to manage and improve customer-supplier relationships, and the outcomes of these tools/practices.

Findings

(Findings are arranged in the form of Questions & Answers that are summary words or phrases of participants' responses or comments to each question.)

Based on your experience, what differences have you observed in customer-supplier relationships between now and 5 or 10 years ago?

1) more dictated and prescribed by customer's policy and procedures;
2) more formal procedures (e.g., ISO 9000 and QS 9000);
3) reduction in supplier base; sometimes just one; for cost reduction;
4) more involvement (pre-contract involvement) before contract such as RFP or proposal stage (driven by customer; due to competition);
5) past: good-old-boy method, informal action   present: less informal contacts; however, still "admission ticket" (informal relationship) exists;
6) past: post-quality   present: basic assumption or supplier's requirement is ISO 9000, SPC, and more effective communication (paradigm change).

How would you describe the word 'partnership'? In other words, what factors do think are the most important ones contributing to the relationship with your partner?

1) win-win scenario; both parties are mutually benefited;
2) responsibility from both parties;
3) good two-way communication: clear answers & responses; both formal & informal;
4) each party needs to have good internal communication systems between different functions;
5) needs for meetings at and with different levels of both organizations, such as meetings between engineering and purchasing that have different interests or upper and lower level managers and employees;
6) longer-term view;
7) mentality for total system cost reduction;
8) more communication at pre-production phase; to meet the requirements such as ISO 9000, QS 9000, and other standards to improve quality;
9) seamless organization;
10) close, frequent, and continuous business relationship;
11) both supplier and customer work together to meet the customer's expectation and goals (supplier's understanding goals of customer organization; customer supports supplier).

To what extent does your company have a true partnership with your customers or suppliers? Do you have a partnership more with customers OR with suppliers? Why?

1) depends on size of customer; the larger, the less partnership;
2) smaller supplier or customer has more partnership; it may be because the larger the organization (usually customer), the more bureaucratic their behavior becomes;
3) proportional to annual sales volume of potential supplier or customer; it sometimes determines the possible business; if the supplier is too small, then it is dangerous to consider the company as partner;
4) ability to solve potential problems.

Could you give me some examples of joint action that your and your partner companies have used jointly?

1) dynamic control planning (initiated by Ford): flow diagram + FMEA (Failure Mode and Effect Analysis) + control plan; planning & prevention tools; assessing risks, trouble shooting; both particular and generic;

2) SPC, management systems analysis;
3) measurement systems; supplier monthly report card (supplier monitoring and measurement tool - delivery time, corrective actions, rate of rejects, service factors, etc.);
4) customer-supplier involvement form; customer-supplier action form; record action items whenever customer and supplier meet; crystallize action items (relates to communication);
5) open issues log: similar to customer-supplier involvement form;
6) pre-launch meeting cross functional;
7) early supplier involvement; customer-supplier involvement meeting identifies opportunities for cost reduction;
8) open-book policy; to reduce cost;
9) designed-in communication;
10) ISO 9000, QS 9000, and other quality standards and requirements;
11) QS 9000 standards & survey to assess supplier's performance;
12) joint problem-solving teams;
13) frequent joint problem-solving meetings and JIT purchasing & delivery.

If you have experienced roadblocks/barriers in using tools and joint practices in the relationship with your partner, what are they?

1) issue of communication;
2) communicate directly with engineers and related people; this is for better feedback from appropriate people;
3) quality expectation: customer needs to be more realistic and needs to have better understanding of manufacturing. process; e.g. 6 sigma or 25 PPM (part per million) are impossible sometimes;
4) unrealistic standardization and use of award criteria;
5) globalization;
6) quality does not have adequate authority to police in manufacturing;
7) a lack of formal award (incentives, recognition) systems to encourage customer or supplier to perform better, such as Senate Productivity and Quality Award and Baldrige Award (more from customer perspectives);
8) supplier does not understand customer's business initiatives/importance;
9) pass blame onto other party.

In terms of roles of your and your partner companies', what changes or differences have you noticed as a result of joint action?

1) suppliers are very helpful in locating or manufacturing better products at a lower price (information provision); this helps customer save money and get better services/products;
2) joint action makes each party better understand partner's situation and goals.

Joint action in the relationship with your partner means there are more frequent and intensive interactions between your and your partner companies. When conflicts or problems arise with customers or suppliers, what happens? How is conflict resolved?

1) informal communication first, and then, if informal procedures do not work, rely on formal channel;
2) communication with responsible people via e-mail;
3) no (or less) conflicts/problems; rely on informal meetings (responsible people meet together and come up with solutions);
4) usually rely on formal channels, such as contacting higher-level or management-level personnel because informal contacts or meetings usually do not work; set up a meeting between representatives and exchange what each party can do (or concede) to resolve problems.

What are conflicts that arise (like delivery performance, not meeting agreements/time commitments, quality problems, etc.)

1) delivery performance rather than quality issues;
2) production requirement and scheduling;
3) customer's complaint about just one bad piece; process issues;
4) too much cost for inspecting all parts and components; possible but cost inefficient;
5) meeting quality demand; no understanding of manufacturing. process from customer side;
6) bureaucratic behavior of big company (usually customer).

One source of conflict can be sudden changes in operations with your partner such as changes in delivery schedules, supply/demand, and other external business environments. How have you reacted to these kinds of sudden changes? In other words, how would you describe the level of flexibility that you and your company have shown in the relationship with your partner? What do you think about your partner's level of flexibility?

1) flexibility almost does not exist (from supplier perspectives);
2) strictly stick to ISO 9000, QS 9000;
3) some flexibility if intent to reduce costs and process time;

4) supplier: very flexible & generous, however, customer: no flexibility;
5) not much flexibility.

In general, how would you share or divide costs and benefits resulting from the joint action with your partner? Are they divided fairly? Do you think your company has been getting at least a fair share of rewards and cost savings from joint action?

1) cost savings are divided relatively evenly because customer can save money and the supplier can obtain future business;
2) cost savings from decreasing in-house inventory (better planning & scheduling in delivery and production).

Could you give me specific performance improvements resulting from the partnerships or joint action?

1) cost savings.

Considering the efforts to improve customer-supplier partnership using tools and joint practices, what types of benefits have arisen?

1) reduced ("system") cost
2) improved communications: customer clearly expresses expectations and supplier is more able to meet those expectation; better feedback and follow-up responses;
3) reduced total time to market for product;
4) customer side: pay less for production; competitive advantage compared to competitors;
5) supplier side: increased efficiency, productivity; reduced internal costs; easier process of mfg.
6) suppliers' learning capability; competitive advantages

Considering the efforts to improve customer-supplier partnership using tools and joint practices, what have been the costs? The downside?

1) policing system is more difficult;
2) time;
3) infrastructure and resources;
4) stringent internal auditing and external (customer) auditing;
5) too many different customer requirements; increasing customer audits because of ISO 9000 and other quality standards.

Are you using exemplary tools and joint practices that other companies are using such as Baldrige winners and ISO 9000 standards? If yes, what are those companies and which of their tools and joint practices are you interested in?

1) ISO 9000 standards & certification as a major supplier selection and performance measurement tool.

What specific trends are you expecting to happen in the relationship with your partner?

1) developing supplier base using QS 9000 criteria;
2) help suppliers use SPC tools.

Assume you are now talking to the individual with whom you have maintained the closest business partnerships for years. What would you like to discuss with him/her to further improve the relationship with the individual and the company he/she is working for?

1) needs for mechanisms that help each party cope with occasions when personnel on the joint problem-solving team change.

Is there anything that I have missed or not asked that I need to know to understand customer-supplier relationships?

1) need to incorporate Japanese customer-supplier relationships with US customer-supplier relationships;

❑ **Subsequent changes in the mailed survey questionnaire**

Changes summarized below were based on the findings from the focus group interview, structured interviews, and continuous committee feedback that were aimed to improve the overall quality of the survey.

Variables and Indicators	Original Items	Type of Changes	Current Items
Organizations and individual demographics	Definition of 'Partnership' added to Part I: # 1 *The partner is the most important supplier, or customer, to your company that is characterized by at least one of the following factors: responsibility; good two-way communication; long-term view; mentality for total system cost reduction; and close, frequent, and continuous business relationship.*		
	Part I: # II-XII	No change	Part I: # II-XII
q1-q3 joint action (Independent variable)			
Joint use of tools Items: Part II (1, 11, 15)	1. With our partner, we are using specific tools to jointly design new products.	Changes in wording	1. We are using specific tools with our partner to jointly design new products.
	11	No change	11.
	15. The relationship involves the use of specific quality tools for long-term planning.	Changes in wording	15. The relationship with our partner involves the use of quality tools for longer term planning.
Joint practices Items: Part II (7, 8, 22, 23, 31, 35, 44)	7, 8, 23, 31, 35, 44	No change	7, 8, 23, 31, 35, 44
	22. The relationship with our partner includes formal evaluation programs and follow-up reports.	Changes in wording	22. The relationship with our partner includes formal evaluation and assessment.
Shared results (Dependent variables) *Role integrity with financial impacts* Items: Part II (9, 12, 16, 24, 38, 41, 43)	9, 12, 16, 38, 41, 43	No change	9, 12, 16, 38, 41, 43
	24. We expect our partner to share any information which would help our company increase quality and productivity.	Changes in wording	24. Our partner shares information to help our company increase quality and productivity.
Role integrity without financial impacts Items: Part II (4, 10, 13, 17, 25, 26, 36, 39, 40)	4, 13, 17, 25, 26, 36, 39, 40	No change	4, 13, 17, 25, 26, 36, 39, 40
	10. Our partner offers specific suggestions to help us in improving our marketing and/or operating procedures.	Changes in wording	10. Our partner offers specific suggestions to help us in improving our processes and procedures.
	45. Our partner shares the responsibility for market share of our products.	Deleted	

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Variables and Indicators	Original Items	Type of Changes	Current Items
Conflict resolution Items: Part II (3, 18, 27, 30, 37, 42)	3, 18, 30, 42 27. Each dispute is treated as further improvement opportunity.	No change Changes in wording	3, 18, 30, 42 27. Each conflict is treated as a further improvement opportunity
	37. No suit is filed by either party if unexpected events occur.	Changes in wording	37. Rather then relying on legal procedures to resolve conflicts (i.e., filing a suit), both parties rely on more informal means.
Flexibility Items: Part II (6, 21, 29, 32)	6, 21, 29, 32	No change	6, 21, 29, 32
Mutuality with financial impacts Items: Part II (2, 5, 19, 20, 28, 33)	2, 5, 19, 20, 28, 33	No change	2, 5, 19, 20, 28, 33
Mutuality with financial impacts Items: Part II (14, 34)	14, 34	No change	14, 34
	Addition of four tools to item # 45 of Part II (Supplier/customer performance measures; In-plant representative; ISO 9000 and/or QS 9000 and/or Baldrige criteria; Dynamic control tools: e.g., flow diagram and FMEA (failure mode effect analysis). Addition of items # 47 and 48 to Part III.		

APPENDIX E. SUMMARY RESULTS OF STRUCTURED INTERVIEWS

This Appendix summarizes results of structured interviews conducted as follows:

Table E-1. Profile of Seven Interviewees (Reproduced)

Date	Interviewee	Title	Company	Location	Perspective(s) taken
07/21/97	1. Michele Meyer (ASQ)	Training administrator	Federal Mogul	Blacksburg, VA	Customer & supplier
07/23/97	2. Donald Clark (SPQA)	Sr. Director, Purchasing	Canon Va, Inc.	Newport News, VA	Customer
07/25/97	3. Mike Mabry (NAPM)	Purchasing manager	Plymouth	Radford, VA	Customer
07/28/97	4. Brendon McSheehy (SPQA)	Director, R & D	Cookson Fibers, Inc.	Bristol, VA	Supplier
07/29/97	5. Kenneth Olszewski (NAPM)	Sourcing manager	Hubell Lighting	Chrstiansburg, VA	Customer
08/01/97	6. David Crites (NAPM)	Purchasing supervisors	AllianTech System	Radford, VA	Customer
08/29/97	7. Melvin Clark (ASQ)	Director, Purchasing	Stanley	Martinsville, VA	Customer

This summary is a shortened version of interviewees' responses/comments transcribed from tape-recorded conversations to be used to support findings from the mailed survey questionnaire.

Other than the partner you thought about in completing this survey, how many other sources do you have with whom your company has the same or similar business relationships? [interview question #3]

1) two or three suppliers for basic commodities;
2) single vs. multiple sourcing depends on situations such as how critical parts and components are and volume of parts and components;
3) multiple suppliers for critical parts; and
4) top 20% out of more than 100 customers are considered partners.

How would you describe the word 'partnership"? In other words, what factors do you think are the most important ones contributing to the relationship with your partner? [interview question #4]

1) suppliers better understanding of the ultimate goal: the success of the customer;
2) work together to meet the customer's requirements;
3) joint venture and research for new product and alternative material development;
4) two companies are committed towards a goal of giving highest quality and cost effective products to customers with reasonable profits to both companies;
5) clean environment concern;
6) willing to share technology development;
7) willing to allocate a part of development resource to make special innovative efforts;
8) a guarantee of best price, product, and quality from suppliers;
9) high economic value / low total cost; and
10) a fair share (economic share, responsibility, etc.).

Could you give me some examples of joint action that you and your partner companies have used jointly? [interview question #7]

1) internal QS 9000 survey and QS 9000 criteria for quality audit;
2) ISO 9000 certification;
3) joint problem-solving teams to discuss problems and future improvement issues;
4) customer's PPM measuring systems;
5) quality advanced task force teams to work with joint venture suppliers (to help suppliers increase their productivity; to discuss further improvement opportunities by identifying suppliers' operations and production flows);
6) joint tooling;
7) "compass review" (a kind of joint design and manufacturing team) to redesign manufacturing processes to make seamless processes;
8) joint planning;
9) "ropes course": joint offsite training/education program;
10) joint planning and research to develop new products;
11) engineering assistance and guidance;
12) JIT delivery; and
13) SPC.

Among the tools and joint practices we are talking about, based on your experience, what tools and joint practices have been used most effectively? [interview question #9]

1) exchange of strategic information, joint problem-solving teams (some tools and joint practices are subset of other tools and joint practices);
2) effectiveness is closely related to money; some effective tools identified are the ones that have contributed a lot to cost savings; and
3) good communication followed by visitation to understand each other's ability better.

And what tools and joint practices have been used least effectively? [interview question #10]

1) joint quality training/education; and
2) suppliers' old AQL type approach.

Do you have other tools and joint practices that you plan to use in the near future in the relationship with your partner? [interview question #11]

1) team development session / team training;
2) good hand-shaking; and
3) more fundamental, basic, and ethical relationship building.

If you have experienced roadblocks/barriers in using tools and joint practices in the relationship with your partner, what are they? [interview question #13]

1) passing blame to other party;
2) suppliers do not understand customers' business initiatives and importance;
3) suppliers do not want to change their business practices, operations and processes;
4) miscommunication between people and different personalities; and
5) suppliers resist using tools and joint practices, SPC for example, because they are too small to hire external consultants and because they have too many orders from other customers.

In terms of roles of your and your partner companies', what changes or differences have you noticed as a result of joint action we just talked about? [interview question #14]

1) joint action helps us understand partners' situation (goals, business scope, problems, etc.) better;
2) suppliers have become much more involved in customers' business;
3) customers reward suppliers for their superior performance (cost, delivery, etc.);
4) joint action forces us to be responsible in terms of how to allocate resources;

5) getting better products at less cost;
6) suppliers' sharing pain and cost of performing poorly;
7) fewer *good old boy* relationships; and
8) better price, quality, delivery, service, and more attention to details.

Could you give me specific performance improvements resulting from the partnerships or joint action? [interview question #15]

1) product cycle : 3 days;
2) high inventory turns;
3) no inspection (trust);
4) product throughput: 25% increase; and
5) reduced claims: 40%

Joint action in the relationship with your partner means there are more frequent and intensive interactions between your and your partner companies. When conflicts or problems arise with customers or suppliers, what happens? How is conflict resolved? [interview question #16]

1) less conflicts and problems;
2) rely on informal channels more than formal channels
3) no law suits at all;
4) resolved at many different levels;
5) rely on informal person-to-person contacts (no memos, letters, meetings); and
6) depend on seriousness; usually try to resolve at lower levels.

One source of conflict can be sudden changes in operations with your partner such as changes in delivery schedules, supply/demand, and other external business environments. How have you reacted to these kinds of sudden changes? In other words, how would you describe the level of flexibility that you and your company have shown in the relationship with your partner? What do you think about your partner's level of flexibility? [interview question #17]

1) suppliers are very flexible and generous, but customers aren't;
2) very flexible; for new products, both customers and suppliers need to be flexible in terms of delivery amount, lead time, tooling capabilities to buffer unexpected situations;
3) very flexible; and
4) willing to flexible with companies that work with us.

In general, how would you share or divide costs and benefits resulting from the joint action with your partner? Are they divided fairly? Do you think your company has been getting at least a fair share of rewards and cost savings from joint action? [interview question #18]

1) divided fairly;
2) by giving more business to suppliers or maintaining a continuous relationship with suppliers, not by sharing financial benefits directly with suppliers;
3) in general, benefits are shared evenly by saving costs independently from each other by using JIT delivery systems;
4) generally 50/50 because we don't want alienate suppliers; and
5) not willing to share costs, but willing to share benefits to suppliers, more and continuous businesses are profits.

What specific trends are you expecting in the relationship with your partner or in customer-supplier relationships in general? [interview question #20]

1) suppliers' using QS 9000 and SPC (if they do not use them now);
2) joint evaluation of alternate materials to develop a total cost-effective production system;
3) paperless operation and transaction;
4) paperless communication;
5) in-plant representative;
6) more joint technology development; and
7) having more market intelligence (joint market analysis).

Assume you are now talking to the individual with whom you have maintained the closest business relationships for years. What would you like to discuss with him/her to further improve the relationship with the individual and the company he/she is working for? [interview question #21]

1) problems associated with suppliers' personnel change;
2) how jointly reduce cost?;
3) how to improve environment?;
4) how to improve employees' quality of work life?;
5) not just professional relationships, but also personal relationships; and
6) speed (faster and better).

Other findings

1) a need for a mix of Japanese and U.S. customer-supplier relationships;

2) suppliers need to be involved in early phases of product design, manufacturing, etc.;
3) sometime third suppliers need to be introduced to better meet the customer's requirements;
4) a global business is very difficult to achieve without partnerships; and
5) Japanese customer-supplier relationship is different because Japanese suppliers work FOR their suppliers.

APPENDIX F. SCALE RELIABILITY ANALYSIS AND HISTOGRAMS

This Appendix presents supporting information about scales: covariance and Pearson correlation coefficients between items, basic statistics about items (such as mean, standard deviation, and minimum and maximum values), and Cronbach's coefficient alphas for both raw and standardized items. Unlike Chapter 3 in which in-depth descriptions of how scales were developed and pilot tests were presented, this Appendix shows SAS outputs (reliability analysis and histograms as well as other information mentioned above) for each scale, using 172 responses.

❑   **Joint use of specific tools (TQMT)**

[TQMT1] We are using specific tools with our partner to jointly design new products.
[TQMT2] People in the two companies use mechanisms or tools to design better quality systems.
[TQMT3] The relationship with our partner involves the use of quality tools for longer term planning.
[PRAC1] Our partner is involved in joint planning activities with us that traditionally were considered only one party's responsibility.
[PRAC3] The relationship with our partner includes formal evaluation and assessment.

5 items: TQMT1   TQMT2   TQMT3   PRAC1   PRAC3

Pearson Correlation Coefficients / N = 172

	TQMT1	TQMT2	TQMT3	PRAC1	PRAC3
TQMT1	1.00000				
TQMT2	0.39743	1.00000			
TQMT3	0.35151	0.53552	1.00000		
PRAC1	0.38716	0.33270	0.30290	1.00000	
PRAC3	0.19471	0.28292	0.28464	0.06832	1.00000

Covariance Matrix   DF = 171

	TQMT1	TQMT2	TQMT3	PRAC1	PRAC3
TQMT1	2.460050320				
TQMT2	0.724466204	1.350741194			
TQMT3	0.609105127	0.687610499	1.220556236		
PRAC1	0.701618387	0.446756426	0.386644907	1.334965320	
PRAC3	0.352543180	0.379572963	0.363015096	0.091119271	1.332619339

```
                         Simple Statistics

Variable         N         Mean      Std Dev           Sum        Minimum        Maximum

TQMT1           172     3.808140    1.568455     655.000000      1.000000       6.000000
TQMT2           172     4.511628    1.162214     776.000000      1.000000       6.000000
TQMT3           172     4.459302    1.104788     767.000000      2.000000       6.000000
PRAC1           172     4.302326    1.155407     740.000000      1.000000       6.000000
PRAC3           172     4.796512    1.154391     825.000000      1.000000       6.000000

Scale TQMT      172    21.8779070   4.1453391                    8.000000      30.000000
Item means      172     4.3755814   0.8290678                    1.600000       6.000000




               Cronbach Coefficient Alpha: 0.710706

                  Raw Variables                    Std. Variables

Deleted       Correlation                     Correlation
Variable      with Total          Alpha       with Total          Alpha
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TQMT1           0.482657         0.731187       0.482294         0.732867
TQMT2           0.571524         0.687997       0.577980         0.690372
TQMT3           0.537615         0.605663       0.544777         0.605378
PRAC1           0.396548         0.759716       0.383520         0.774365
PRAC3           0.279898         0.703569       0.282987         0.714219
```

357

Frequency

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      1.5       2.0       2.5       3.0       3.5       4.0       4.5       5.0       5.5       6.0
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TQMT Midpoint   [Mean: 4.38 Std Dev: 0.83   N: 172]

358
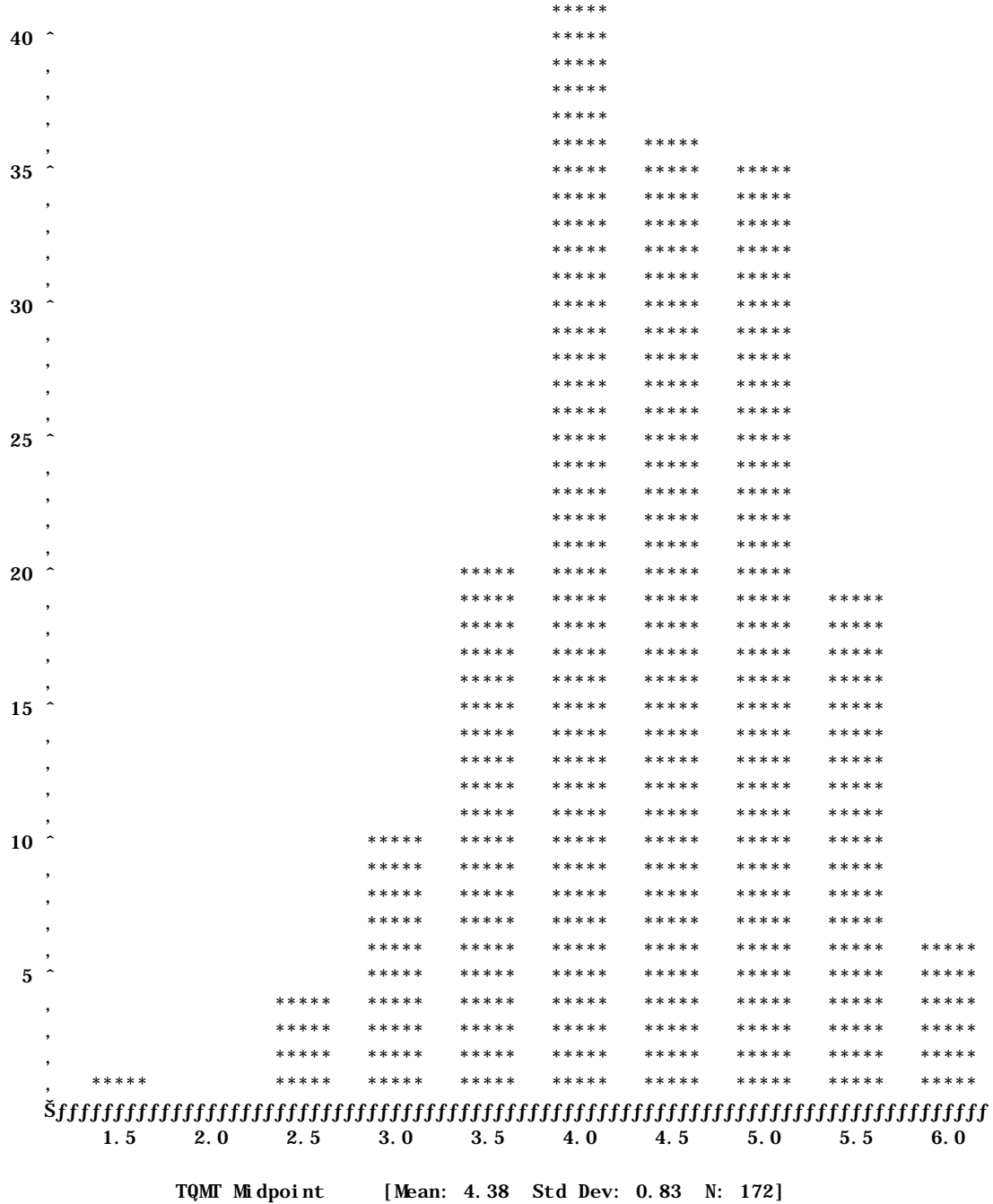
❑ **Joint practices (PRAC)**

[PRAC2] In the relationship with our partner, there is an exchange of strategic information, such as cost and price structure.
[PRAC5] The relationship with our partner involves frequent personal contacts for exchange of ideas and information.
[PRAC6] We are willing to put aside contract terms in order to jointly work through difficult technical or quality problems that arise.
[PRAC7] The relationship could be described as a 'long-term joint venture' or partnership.

```
                    4 items:  PRAC2     PRAC5     PRAC6     PRAC7

                 Pearson Correlation Coefficients / N = 172

                      PRAC2             PRAC5             PRAC6             PRAC7

        PRAC2       1.00000
        PRAC5       0.25381           1.00000
        PRAC6       0.19309           0.33674           1.00000
        PRAC7       0.32608           0.38339           0.39848           1.00000

                      Covariance Matrix      DF = 171

                      PRAC2             PRAC5             PRAC6             PRAC7

        PRAC2     2.069631443
        PRAC5     0.396028832       1.176390589
        PRAC6     0.315789474       0.415204678       1.292397661
        PRAC7     0.481436149       0.426764586       0.464912281       1.053277574


                            Simple Statistics

    Variable         N        Mean      Std Dev          Sum       Minimum       Maximum

    PRAC2           172     3.976744    1.438621     684.000000    1.000000      6.000000
    PRAC5           172     4.930233    1.084615     848.000000    2.000000      6.000000
    PRAC6           172     4.500000    1.136837     774.000000    1.000000      6.000000
    PRAC7           172     4.831395    1.026293     831.000000    1.000000      6.000000

    Scale PRAC      172    18.2383721   3.2545306                  7.000000     24.000000
    Item means      172     4.5595930   0.8136326                  1.750000      6.000000


                    Cronbach Coefficient Alpha:  0.648092

                   Raw Variables                    Std. Variables

        Deleted      Correlation                       Correlation
        Variable     with Total         Alpha          with Total           Alpha
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        PRAC2        0.334850         0.638976         0.337765           0.640763
        PRAC5        0.433289         0.545626         0.442913           0.569340
        PRAC6        0.400249         0.566419         0.418231           0.586582
        PRAC7        0.513359         0.497768         0.518429           0.514726
```

359

Frequency

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  50 ^                                             *****
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          1.5     2.0     2.5     3.0     3.5     4.0     4.5     5.0     5.5     6.0
```

PRAC Midpoint   [Mean: 4.56   Std Dev: 0.81   N: 172]

360
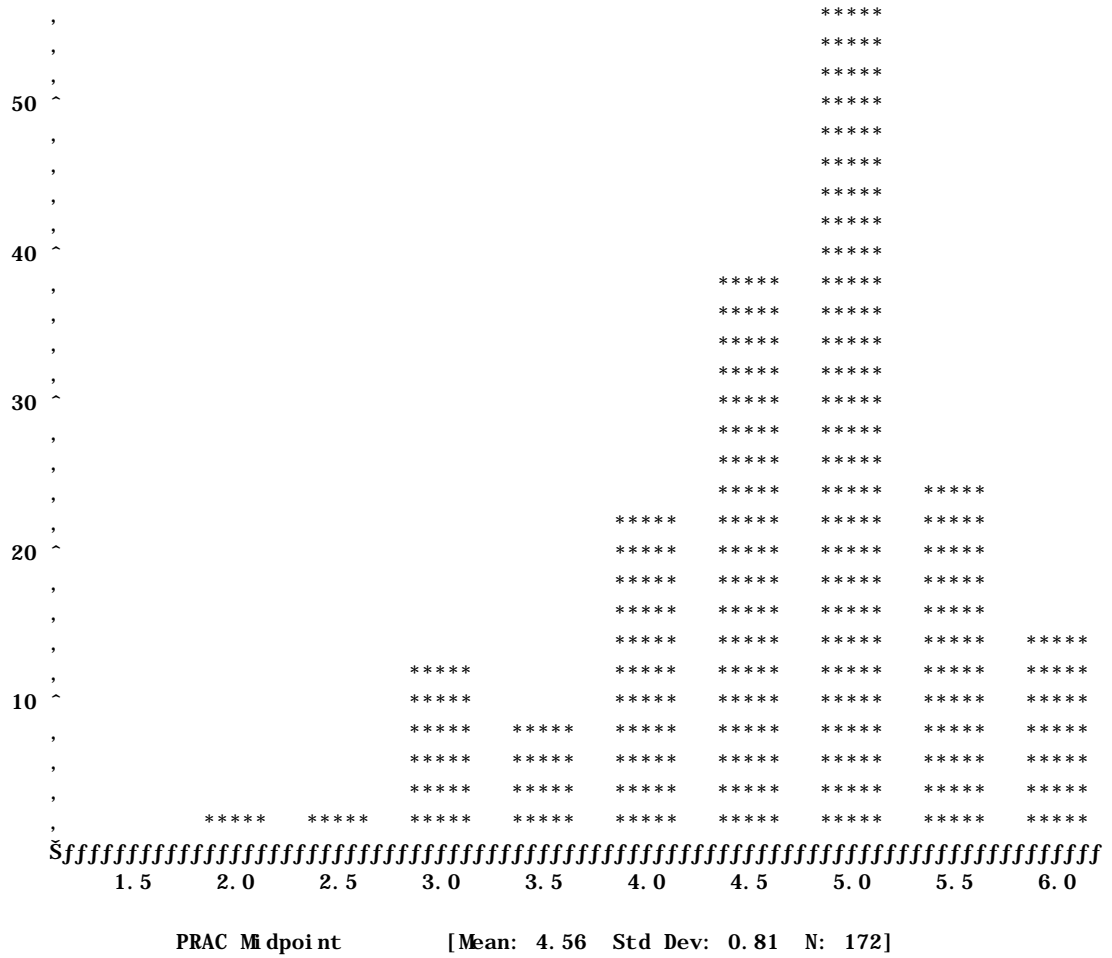
❑ Informed partners (INFPRT)

[RIW4] Our partner shares information to help our company increase quality and productivity.
[RIW5] We provide each other with technical support in substantial detail.
[RIW7] Our partner helps us identify cost reduction opportunities.
[RIWO1] Both parties share information on performance in meeting the expectations and needs of the other.
[RIWO2] Our partner offers specific suggestions to help us improve our processes and procedures.
[RIWO3] Our partner is responsive in maintaining a cooperative relationship with us.
[RIWO6] The relationship with our partner includes diverse expectations over many issues.
[RIWO7] We keep each other informed about events or changes that may affect the other party.
[RIWO8] We regularly provide our partner with long-range forecasts of supply capabilities or demand requirements.

9 items: RIW4   RIW5   RIW7   RIWO1   RIWO2   RIWO3   RIWO6   RIWO7   RIWO8

Pearson Correlation Coefficients / N = 172

	RIW4	RIW5	RIW7	RIWO1	RIWO2	RIWO3	RIWO6	RIWO7	RIWO8
RIW4	1.00000								
RIW5	0.41926	1.00000							
RIW7	0.39071	0.26952	1.00000						
RIWO1	0.41154	0.25669	0.37393	1.00000					
RIWO2	0.53767	0.20260	0.38225	0.23714	1.00000				
RIWO3	0.43521	0.40400	0.35856	0.35402	0.33889	1.00000			
RIWO6	0.33362	0.27542	0.32129	0.25995	0.26035	0.19350	1.00000		
RIWO7	0.34226	0.37666	0.38806	0.34463	0.21605	0.43658	0.22662	1.00000	
RIWO8	0.26567	0.26727	0.42898	0.37715	0.24723	0.18873	0.36172	0.23827	1.00000

Covariance Matrix   DF = 171

	RIW4	RIW5	RIW7	RIWO1	RIWO2	RIWO3	RIWO6	RIWO7	RIWO8
RIW4	1.20264								
RIW5	0.46301	1.01411							
RIW7	0.49014	0.31049	1.30858						
RIWO1	0.55875	0.32004	0.52958	1.53281					
RIWO2	0.71889	0.24874	0.53312	0.35795	1.48647				
RIWO3	0.47348	0.40361	0.40691	0.43482	0.40990	0.98419			
RIWO6	0.40208	0.30481	0.40392	0.35370	0.34884	0.21097	1.20777		
RIWO7	0.33680	0.34037	0.39834	0.38287	0.23637	0.38865	0.22348	0.80522	
RIWO8	0.32653	0.30165	0.54998	0.52332	0.33782	0.20985	0.44553	0.23963	1.25609

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
RIW4	172	4.360465	1.096649	750.000000	1.000000	6.000000
RIW5	172	4.819767	1.007030	829.000000	2.000000	6.000000
RIW7	172	4.325581	1.143932	744.000000	1.000000	6.000000
RIW01	172	4.668605	1.238067	803.000000	1.000000	6.000000
RIW02	172	4.372093	1.219208	752.000000	1.000000	6.000000
RIW03	172	4.936047	0.992064	849.000000	1.000000	6.000000
RIW06	172	4.552326	1.098987	783.000000	1.000000	6.000000
RIW07	172	4.587209	0.897338	789.000000	2.000000	6.000000
RIW08	172	4.534884	1.120752	780.000000	1.000000	6.000000
Scale INFPRT	172	41.1569767	6.2167298		22.000000 54.000000	
Item means	172	4.5729974	0.6907478		2.444444	6.000000

Cronbach Coefficient Alpha: 0.812924

	Raw Variables		Std. Variables	
Deleted	Correlation		Correlation	
Variable	with Total	Alpha	with Total	Alpha
∫∫∫				
RIW4	0.628580	0.776172	0.625038	0.779644
RIW5	0.470863	0.796126	0.480080	0.797859
RIW7	0.577248	0.782492	0.575594	0.785957
RIW01	0.508757	0.792157	0.510757	0.794078
RIW02	0.471860	0.797104	0.469641	0.799136
RIW03	0.525308	0.790022	0.531120	0.791547
RIW06	0.432872	0.800923	0.429806	0.803970
RIW07	0.495892	0.794144	0.500911	0.795296
RIW08	0.466319	0.796923	0.459689	0.800350

Frequency

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 60 ^                                                     *****
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 50 ^                                                     *****
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INFPRT Midpoint   [Mean: 4.57   Std Dev: 0.69   N: 172]

❑ Role integrity (RI)

[RIW1] We have made financial investments in our company, such as tooling, equipment, and training employees, dedicated to the relationship with our partner.
[RIW2] If our relationship with our partner were discontinued, our sales would suffer.
[RIWO4] From time to time, we are willing to make sacrifices to help our partner.
[RIWO5] Both parties have multi-dimensional roles that go beyond the mere buying and selling of products.
[RIWO9] We are responsive in maintaining a cooperative relationship with our partner.

5 items: RIW1   RIW2   RIWO4   RIWO5   RIWO9

Pearson Correlation Coefficients / N = 172

	RIW1	RIW2	RIWO4	RIWO5	RIWO9
RIW1	1.00000				
RIW2	0.31304	1.00000			
RIWO4	0.34751	0.29736	1.00000		
RIWO5	0.16278	0.12796	0.21390	1.00000	
RIWO9	0.27160	0.19213	0.37547	0.39010	1.00000

Covariance Matrix   DF = 171

	RIW1	RIW2	RIWO4	RIWO5	RIWO9
RIW1	1.582619339				
RIW2	0.654970760	2.766081871			
RIWO4	0.449748402	0.508771930	1.058343533		
RIWO5	0.194138447	0.201754386	0.208622331	0.898782810	
RIWO9	0.293893649	0.274853801	0.332245342	0.318101455	0.739834081

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
RIW1	172	4.546512	1.258022	782.000000	1.000000	6.000000
RIW2	172	4.500000	1.663154	774.000000	1.000000	6.000000
RIWO4	172	4.511628	1.028758	776.000000	1.000000	6.000000
RIWO5	172	4.912791	0.948042	845.000000	2.000000	6.000000
RIWO9	172	5.093023	0.860136	876.000000	2.000000	6.000000
Scale RI	172	23.5639535	3.7309332		13.000000	30.000000
Item means	172	4.7127907	0.7461866		2.600000	6.000000

Cronbach Coefficient Alpha: 0.688095

	Raw Variables		Std. Variables	
Deleted	Correlation		Correlation	
Variable	with Total	Alpha	with Total	Alpha
RIW1	0.418512	0.537413	0.408232	0.691958
RIW2	0.351505	0.608572	0.339252	0.724371
RIW04	0.464090	0.523914	0.469352	0.562087
RIW05	0.291108	0.599981	0.324678	0.631046
RIW09	0.432445	0.550621	0.467140	0.663187

Frequency

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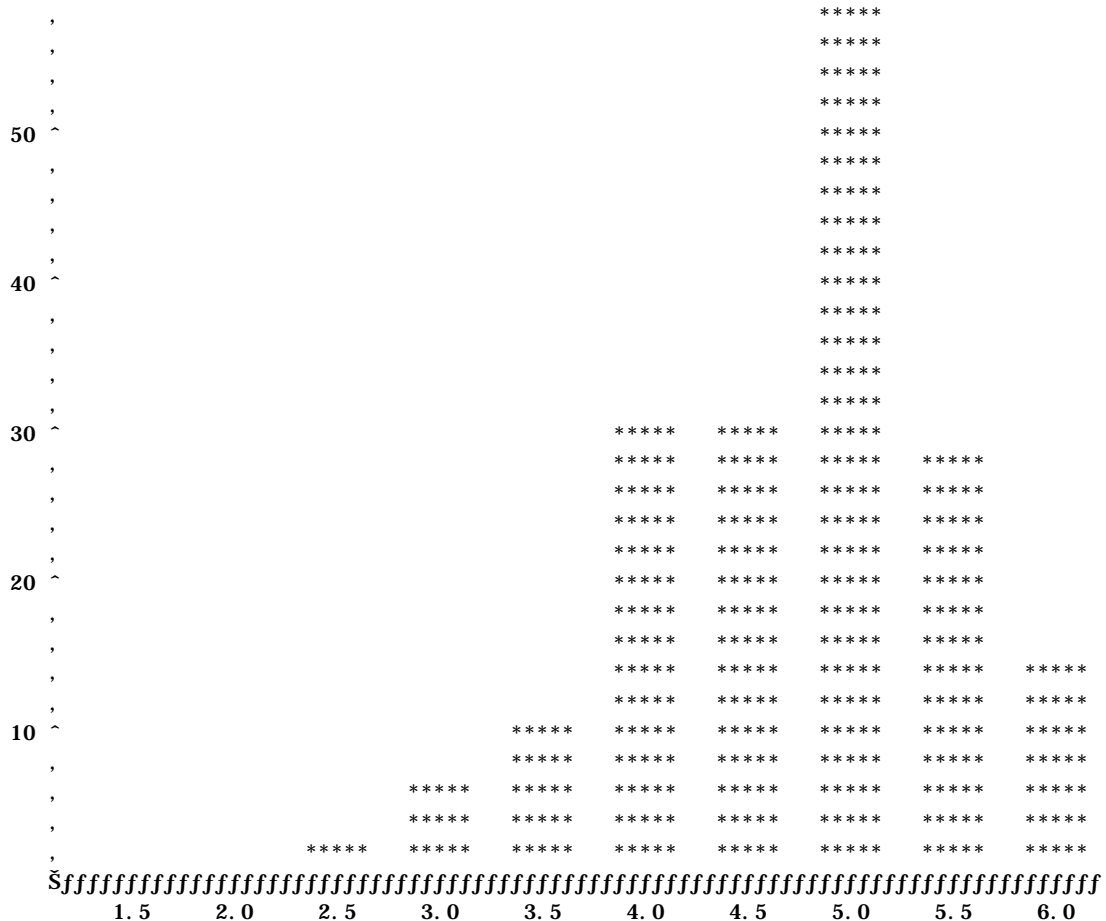
RI Midpoint   [Mean: 4.71 Std Dev: 075 N: 172]

❑ Conflict resolution (CR)

[CR2] Problems that arise in the course of this relationship are treated as *joint* rather than *individual* responsibilities.
[CR3] Each conflict is treated as a further improvement opportunity.
[CR4] Neither party abuses its power over the other party.
[CR5] Rather than relying on legal procedures to resolve conflicts (i.e., filing a suit), both parties rely on more informal means.
[CR6] Temporary setbacks in our partner's performance commitment are accepted and resolved in an aligned and negotiated way.
[FLEX3] The relationship with our partner can be characterized as flexible.
[FLEX4] Our partner is flexible in response to requests we make.

```
            7 items:   CR2      CR3      CR4      CR5      CR6      FLEX3    FLEX4
```

Pearson Correlation Coefficients / N = 172

	CR2	CR3	CR4	CR5	CR6	FLEX3	FLEX4
CR2	1.00000						
CR3	0.40856	1.00000					
CR4	0.64305	0.44449	1.00000				
CR5	0.38964	0.33771	0.42706	1.00000			
CR6	0.48347	0.42097	0.53675	0.31645	1.00000		
FLEX3	0.55120	0.45745	0.60569	0.40667	0.58145	1.00000	
FLEX4	0.55400	0.33922	0.57552	0.34093	0.52437	0.70645	1.00000

Covariance Matrix   DF = 171

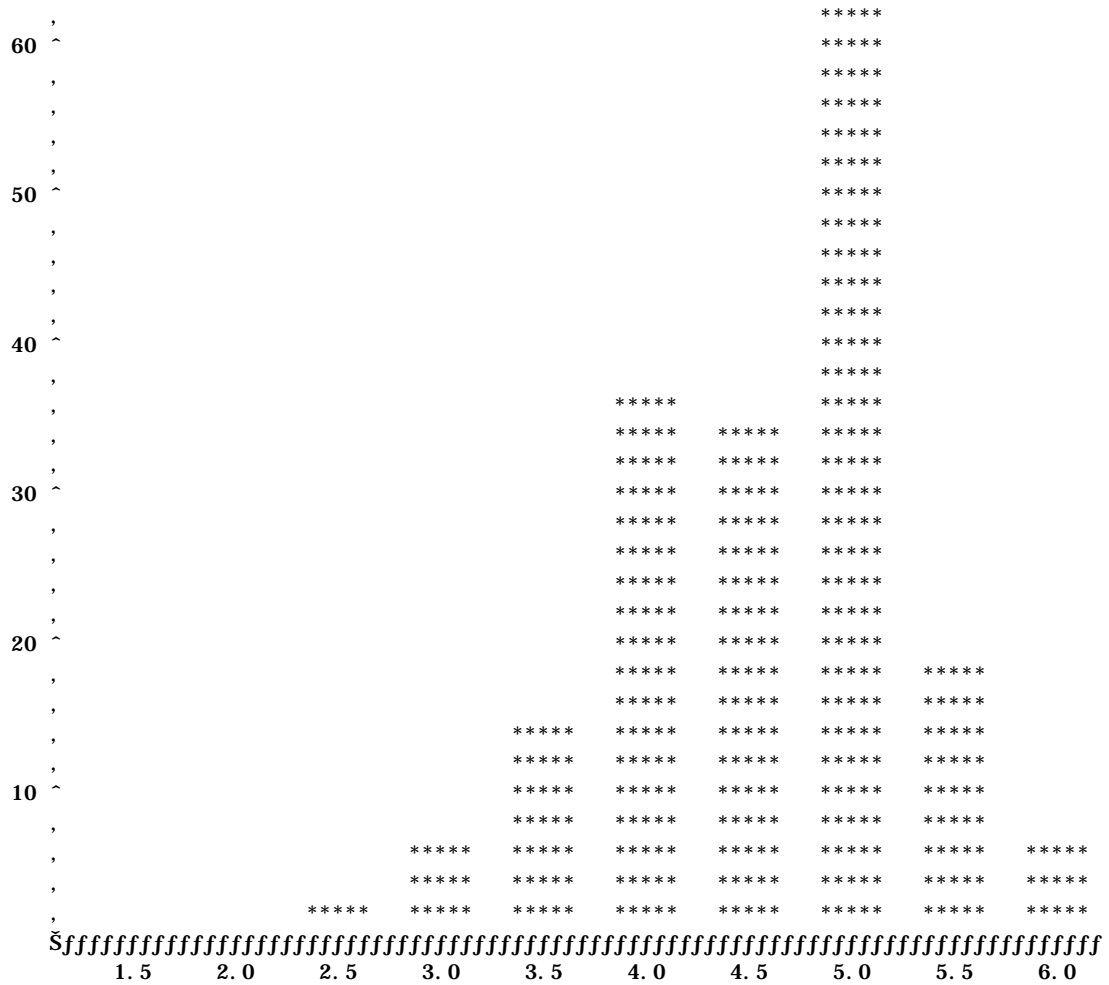|	CR2	CR3	CR4	CR5	CR6	FLEX3	FLEX4
CR2	1.19148647						
CR3	0.42554060	0.91051272					
CR4	0.89725282	0.54215966	1.63399293				
CR5	0.37039304	0.28063375	0.47541820	0.75843193			
CR6	0.49598803	0.37753298	0.64483884	0.25900993	0.88331293		
FLEX3	0.61532708	0.44641643	0.79181967	0.36219910	0.55888753	1.04593363	
FLEX4	0.63355093	0.33911329	0.77073983	0.31106351	0.51631987	0.75693594	1.09761322

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
CR2	172	4.244186	1.091552	730.000000	1.000000	6.000000
CR3	172	4.267442	0.954208	734.000000	1.000000	6.000000
CR4	172	4.180233	1.278277	719.000000	1.000000	6.000000
CR5	172	5.087209	0.870880	875.000000	3.000000	6.000000
CR6	172	4.313953	0.939847	742.000000	1.000000	6.000000
FLEX3	172	4.470930	1.022709	769.000000	2.000000	6.000000
FLEX4	172	4.587209	1.047670	789.000000	1.000000	6.000000
Scale CR	172	31.1511628	5.4095809		14.000000	41.000000
Item means	172	4.4501661	0.7727973		2.000000	5.857143

Cronbach Coefficient Alpha: 0.835338

	Raw Variables		Std. Variables	
Deleted	Correlation		Correlation	
Variable	with Total	Alpha	with Total	Alpha
CR2	0.684134	0.841642	0.676795	0.840760
CR3	0.520969	0.862863	0.522019	0.861740
CR4	0.732441	0.835558	0.729470	0.833346
CR5	0.478689	0.867233	0.476615	0.867671
CR6	0.637390	0.848709	0.634365	0.846630
FLEX3	0.750787	0.832682	0.749622	0.830473
FLEX4	0.684853	0.841645	0.679514	0.840381

Frequency

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CR Midpoint   [Mean: 4.45 Std Dev: 0.77 N: 172]
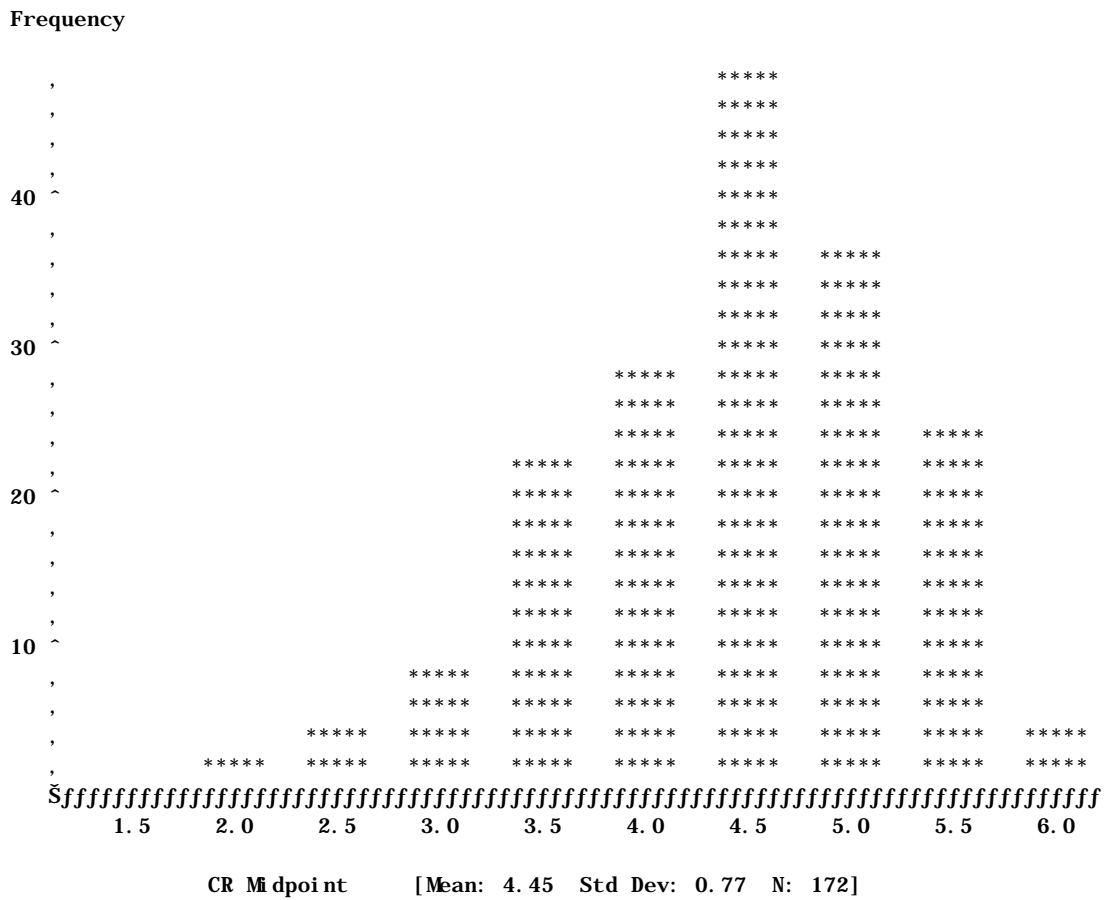
❑ Mutuality (MU)

[MUW3] Our company gets a fair share of the financial rewards and cost savings from the relationship with our partner.
[MUW4] Benefits from problem solving with our partner are shared jointly.
[MUWO1] Both parties are committed to improvement that benefits the relationship as a whole, not just the individual parties.
[MUWO2] There is a strong spirit of fairness in the relationship with our partner.

```
                    4 items:   MUW3      MUW4      MUWO1     MUWO2

                     Pearson Correlation Coefficients / N = 172

                          MUW3            MUW4            MUWO1           MUWO2

          MUW3          1.00000
          MUW4          0.65571         1.00000
          MUWO1         0.55071         0.54985         1.00000
          MUWO2         0.58186         0.56430         0.65577         1.00000

                          Covariance Matrix      DF = 171

                          MUW3            MUW4            MUWO1           MUWO2

          MUW3        1.028525772
          MUW4        0.683462532     1.056303550
          MUWO1       0.583537332     0.590439276     1.091629267
          MUWO2       0.657690738     0.646402829     0.763633891     1.242214062

                              Simple Statistics

  Variable       N        Mean      Std Dev        Sum        Minimum       Maximum

  MUW3          172     4.296512    1.014163    739.000000    1.000000      6.000000
  MUW4          172     4.453488    1.027766    766.000000    1.000000      6.000000
  MUWO1         172     4.808140    1.044811    827.000000    1.000000      6.000000
  MUWO2         172     4.441860    1.114547    764.000000    1.000000      6.000000

  Scale MU      172    15.3837209   2.1256914                 8.000000     21.000000
  Item means    172     3.8459302   0.5314228                 2.000000      5.250000


                     Cronbach Coefficient Alpha: 0.853561

                     Raw Variables                    Std. Variables

  Deleted      Correlation                    Correlation
  Variable     with Total        Alpha        with Total         Alpha
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  MUW3          0.698070        0.811980        0.699281        0.841909
  MUW4          0.688146        0.815859        0.690138        0.815763
  MUWO1         0.686283        0.816563        0.683456        0.818568
  MUWO2         0.706713        0.808597        0.706092        0.869026
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Frequency

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MU Midpoint   [Mean: 3.85   Std Dev: 0.53   N: 172]
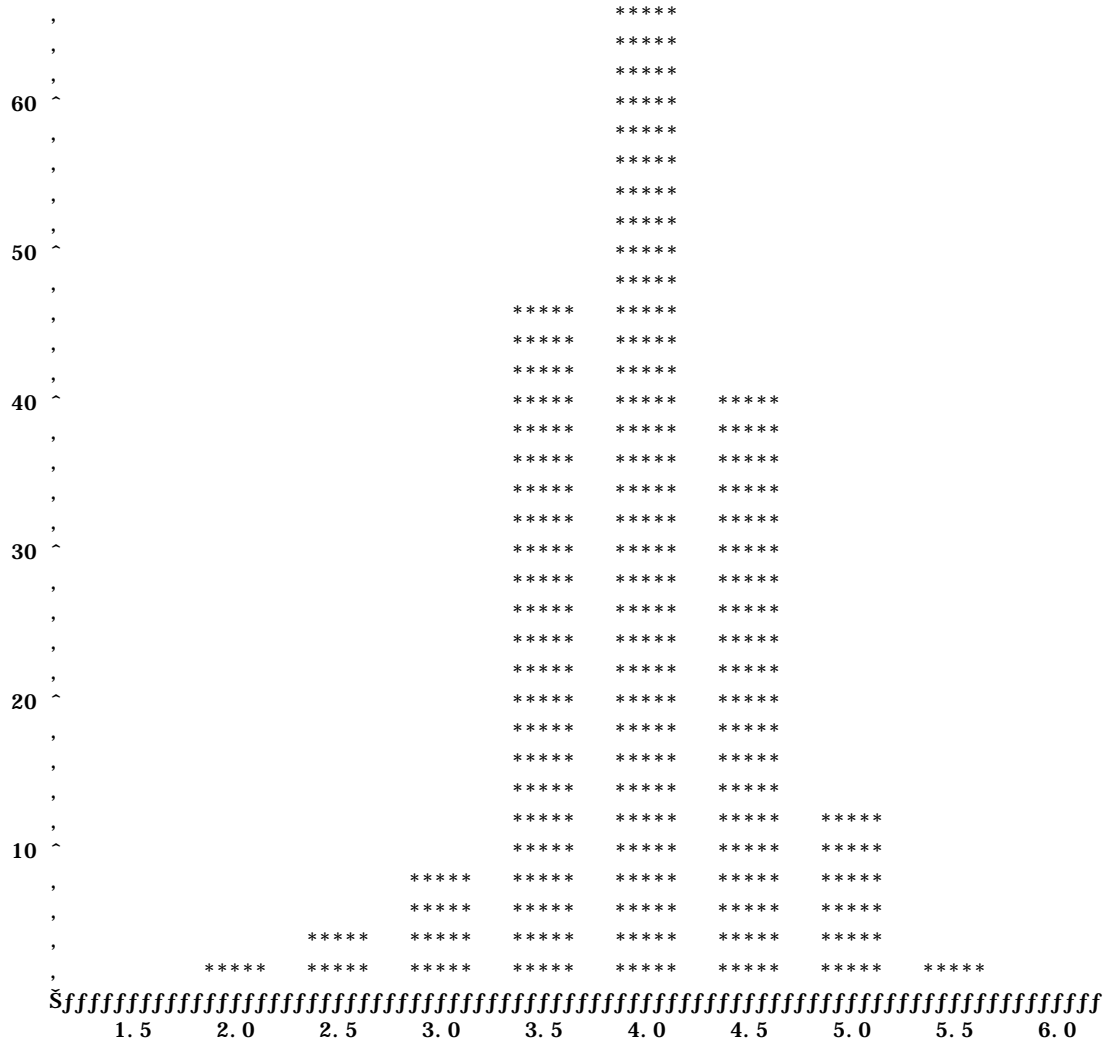
VITA

Seungho Jung

Education   1993 (spring) - 1997 (fall)   Blacksburg, Virginia (USA)

Virginia Polytechnic Institute and State University (VPI & SU; Virginia Tech)
Ph.D. / Industrial & Systems Engineering (Management Systems Engineering emphasis)

- Dissertation topic: *An Empirical Investigation of Tools and Joint Practices Used in Managing Customer-Supplier Relationships*
- Research advisor: Dr. Eileen Van Aken.

1990 (fall) - 1995 (summer)   Newark, Delaware (USA)

University of Delaware
MS / Operations Research (Business & Management emphasis)

- Thesis topic: *Optimal Contractor-type and Action Combinations of Sole-Source Procurement Contract*
- Research advisor: Dr. Pamela C. Brown.

March 1983 - February 1990   Seoul (Korea)

Kyung Hee university
BS / Industrial Engineering.

Work Experience   1996 (summer) - 1997 (fall)   Blacksburg, Virginia (USA)

Center for Organizational Performance Improvement
Resource Center Administrator
Major roles include:

- Maintaining and updating academically rigorous and practically applicable, grounded resources – books, journals/magazines, catalogues, audio- and video materials, world-wide quality and productivity related networks, etc.;
- Locating and providing information about specific topics, such as benchmarking, change management, 360-degree feedback, business process re-engineering, customer-supplier relationships, ---, from university library, internet, and various journals/magazines, on customers' request; and
- Managing important processes that help internal employees and external customers exercise **continuous learning experience** such as *Journal Reviewing Process* and *Position Paper Process*.
- The scope of internal employees and external customers:
  - Internal employees include:

370

- Director and associate director,
- Five full-time professional consultants (Ph.Ds),
- Two managers in Marketing/Business Development,
- Four full-time support staffs, and
- Two part-time office specialists.

1994 (summer) - 1996 (spring)   Blacksburg, Virginia (USA)

Virginia Quality and Productivity Center
Member of Research & Development Team (RDT)
Major roles include:

- Generating and effectively sharing knowledge on organizational performance improvement with external customers;
- Publishing papers;
- Designing and developing specific customer interventions and presentations;
- Acting as process observers to the center; and
- Identifying new learning and research areas within the center.

1994 (summer) - 1995 (summer)   Blacksburg, Virginia (USA)

Industrial & Systems Engineering at Virginia Tech
Project Manager of the World Academy of Productivity Science (WAPS) Delphi Study

- Project title: Delphi Study on Root Causes of Implementation and Deployment Problems of Quality and Productivity Improvement Initiatives at the Regional, National, and Organizational Levels
- Sponsored by World Academy of Productivity Science (WAPS) and Virginia Quality and Productivity Center
- Directed by Dr. D. Scott Sink, President of WAPS and Professor at Industrial & Systems Engineering, Virginia Tech
- Findings from the project were presented at the 9th World Productivity Congress (WPC) in Istanbul-Turkey on June 16th, 1995.

May, 1994 - May, 1995   Blacksburg, Virginia (USA)

Korean Student Association at Virginia Tech
Public Relations Officer.

June 18th, 1985 - September 17th, 1987   Korea

Korean Army (22nd Division Computer Center)
System Analyst & Operator.

Academic Experience   June 1994 - 1997 (fall)   Blacksburg, Virginia (USA)

Industrial & Systems Engineering at Virginia Tech
Graduate Research Associate.

1995 (fall) - 1997 (fall)   Blacksburg, Virginia (USA)

Industrial & Systems Engineering at Virginia Tech
Invited Guest Speaker

- On undergraduate course at Virginia Tech (Engineering cultures: Humanities, Technologies, and Physical Sciences)

- Helped young American and other students from other countries improve their ability to understand and assess engineering problem-solving in historical and global perspectives by introducing and teaching the historical development of Korean engineering and economy.

1994 (fall)   Blacksburg, Virginia (USA)

Industrial & Systems Engineering at Virginia Tech
Ph.D. Plan of Study include 'College Teaching (EdCI 6644)'

- Course covered cognitive learning theories, teaching techniques, cooperative learning groups, course development, and testing theory. Course project involved departmental curriculum development processes.

See below   Blacksburg, Virginia (USA)

Industrial & Systems Engineering at Virginia Tech
Presented Guest Lectures on Various Topics to Several Classes

- Manufacturing costs and production economics (ISE 5234; 1993 [spring]): *Reducing the cost of quality through test data management*

- Management of change, innovation, and performance in organizational systems I (ISE 5015; 1993 [fall]): *Performance improvement of organizational systems*

- Management of change, innovation, and performance in organizational systems II (ISE 5016; 1994 [spring]): *How to design, develop, implement a successful new or enhanced performance measurement system to drive and support improvement for an organizational system*

- College teaching (EdCI 6644; 1994 [fall]): *What is quality in general?*

- Organizations in society (SOC 5604; 1995 [fall]): *Decision making and its contributing factors in five organizational structures*

- The systems engineering process (ENGR 5004; 1995 [fall]): *'Center for Organizational Performance Improvement' viewed from systems perspectives*

- Applied systems engineering (ENGR 5104; 1996 [spring]): *Systems dynamics approach for the customer-supplier relationship.*

Publications

Seungho Jung (fall 1997). **An Empirical Investigation of Tools and Joint Practices Used in Managing Customer-Supplier Relationships** (Ph.D. dissertation). Industrial & Systems Engineering, Virginia Tech.

Seungho Jung and Eileen Van Aken (1997). **Joint Action and Shared Results: New Measurement Dimensions of Customer-Supplier Partnerships**. *Industrial Engineering Research Conference (IERC) Proceedings*, p. 867 – 872.

Seungho Jung (September 1996). **An Investigation into the Proposed Consequences of**

Customer-Supplier Partnerships and Their Joint Use of TQM Tools. *Asian-Pacific Conference on Computational Mechanics (APCOM).*

Seungho Jung (summer 1995). **Optimal Contractor-type and Action Combinations of Sole-source Procurement Contract** (MS thesis). Operations Research, University of Delaware.

D. Scott Sink and Seungho Jung (June 1995). **Delphi Study on Root Causes of Implementation and Deployment Problems of Quality and Productivity Improvement Initiatives at the Regional, National, and Organizational Levels**. Industrial & Systems Engineering, Virginia Tech. Presented as an invited guest paper at the 9[th] World Productivity Congress (WPC) in Istanbul-Turkey on June 16[th], 1995.

Professional Memberships	Member, Operations Research Society of America (ORSA); 1990 - 1995

Member, Operations Research Society of America (ORSA); 1990 - 1995

Member, Institute of Industrial Engineers (IIE); 1996 - Present

Member, Korean-American Scientist and Engineers Association (KSEA): 1996 - Present

Member, American Society for Quality (ASQ); 1997 - Present

Member, America Society for Training & Development (ASTD); 1997 - Present.