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Buyer–supplier operational practices, sourcing policies and plant performances: results of an empirical research

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On the basis of empirical research on a sample of Italian plants, this study: (i) analyses the relationships between advanced buyer–supplier operational interaction practices (design link, logistic link, quality link) and the basic options of the buyer's purchasing strategy, e.g. sources selection criteria, supply base reduction policies, long-term perspectives granted to suppliers (stability of procurement); and (ii) compares these operational practices and purchasing policies in different performing plants. In other words, this study verifies if advanced buyer–supplier interaction practices and 'cooperative' supply management policies exhibit a predictive validity of the plant performances.

The survey involved 497 respondents in 52 plants of two industries (electronic and mechanical). The study demonstrates that the establishment of an advanced operational link with sources significantly influences the basic option of the buying firm's purchasing strategy. In addition, it demonstrates that better performing plants exhibit a higher level of design and logistic interactions, and a better use of long-term supply agreements with sources.

1. Introduction

'Traditional' supply management is characterized by four elements (Jackson 1985). First, the buyer interacts with many suppliers (order fragmented into several sources), in order to maintain multiple market alternatives and promote bidding competition among them. Second, the supply relationship is short-term, since the buyer wants to retain the possibility of switching the actual supply relationships quickly and opening new ones depending on favourable market opportunities. Third, price is the main vendor selection criteria, determined by competitive pressure in the supply market. Fourth, the customized effort of sources is kept low, since the buyer wants to have ready source replacement possibilities.

These four elements characterize 'traditional' ('adversarial' or 'arm's length') supply management. Though not recent, the debate concerning the conditions of its practicability, efficacy and efficiency, and its advantages and disadvantages in comparison with 'non-market exchanges', is now of great topical interest (Johnston and Lawrence 1988, Helper 1991, Imrie and Morris 1992). For example, in recent years, great attention has been given to the automotive Japanese supply system, which is reputed to be one the major success factors of the Japanese automotive industry (Womack *et al.* 1990, Fruin 1992, Richardson 1993).

The new current interest in the different forms of buyer–supplier exchange is to a large extent promoted by the diffusion of new approaches to operations.

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Management and production systems, e.g. 'Just-in-Time', 'Total Quality Management' and 'Concurrent Engineering', promote the adoption of quality control tools spread along the supply chain, integrated coordination of production flows, and cooperation between all those units (inside or outside the firm's boundaries) involved in the product development. The new innovative 'lean production practices' need to be implemented along the full production and logistic chain for full exploitation, in order to synchronize the flows at the upper and lower end of the supply pipeline (Lamming 1996). In this context, Transaction Cost theorists would predict a failure of the traditional market-based exchange, i.e. failure of procurement logic based on 'multiple sourcing', on a priced-based mechanism in the sources selection, on short term horizons (Williamson 1979, 1985). The reasons for this failure can be understood using the TCE concept of 'transaction costs'.

According to TCE, the transaction costs of exchange are the most significant determinants for the governance form of buyer–supplier relationships (Williamson 1979, 1985). Transaction costs include the cost of reaching a satisfactory agreement to both sides, adapting the agreement to unanticipated contingencies, and enforcing its terms. Transaction costs are largely determined by the extent to which the assets required by the relationship are transaction specific, i.e. the extent to which assets can not be redeployed towards alternative uses and by alternative users without sacrificing production value. There are three main kinds of asset specificity. The first is site specificity, an example being that of successive stations located in a cheek-by-jowl relation to each other so as to economize on inventory and transportation expenses. The second is physical asset specificity, an example being that of specialized dies that are required to produce a component, and the third is human asset specificity. Assets specificity creates dependency: buyers cannot easily turn to alternative sources, and suppliers cannot sell outputs intended for one buyer without difficulties. In addition, assets specificity poses added contracting hazards: self-interested behaviour ('opportunism') is likely to emerge from the party whose losses are lower if the relationship is terminated.

Uncertainty on the patterns of the exchange is another determinant of transaction costs (Williamson 1975, 1985). It refers to the degree to which one party cannot anticipate or predict the future environment (i.e. unpredictable changes in consumers' preferences) or the other party's behaviour (i.e. lack, disclosures or distortion of information concerning the product supplied). Transactions for which uncertainty is low require little adaptation, hence little governance, and thus can be organized through market contracting. Also, uncertainty is irrelevant where transactions are non-specific: new trading relations can be easily arranged without the loss of the specific asset, i.e. without additional costs. Whenever assets are specific, increasing the degree of uncertainty makes it imperative that the parties "devise a machinery to 'work things out' since contractual gaps will be larger and the occasion for sequential adaptation will increase" (Williamson 1985, p. 58). Therefore, the presence of specific investments and uncertainty on the contractual patterns raises the costs associated with the 'ex ante' definition of the contract (e.g. the definition of the purchasing clauses) and those associated with its 'ex-post' control (e.g. enforcement costs).

The setting up of an advanced buyer–supplier operational link determines a large amount of specific investments and high level of uncertainty, therefore developing in a regime of high contractual incompleteness. Buyer–supplier operational synchronization and design synergy promoted by JIT, TQM or co-design approaches are associated with site, physical and human asset specificity. For example, site assets specificity arises when the supplier locates his warehouses or assembly lines in proximity to the buyer's plant in order to guarantee JIT deliveries. Physical assets specificity arises when the transaction imposes the acquisition of specific tools, as compatible CAD-CAM systems required by the co-design approach. Human specific assets associated with JIT and TQM systems can involve the training of personnel, development of specific quality assurance practices or compatible procedures to meet the partner's idiosyncratic requirements. The 'continuous improvement' JIT key concept fosters long-term relationships, not only because the improvement needs time for full development, but also because the switching of the relationship also imposes the re-establishment of those specific capabilities developed over time. Particularly relevant seems to be the human specific assets required by co-design activities: joint product development is a process presenting a relevant 'tacit' component and demanding a narrow interaction between the designer and product engineers in order to provide prompt and continuous bi-directional feedback. This kind of innovative synergy needs relational resources distributed over time and matured through the progressive deeper knowledge of the partner's requirements.

In addition, the contractual incompleteness associated with the buyer–supplier exchange when an operational link is established is augmented due to added environmental and behavioural uncertainty. In fact, the exchange becomes more difficult to define ex-ante, since it involves not only the supply of an 'object' alone, but also complex bi-directional logistic, design and informative services. Moreover, it is also more difficult to measure ex-post, given the difficulty of circumscribing the respective responsibilities and ambiguities in performance evaluation. Co-design activities, e.g. need continuous interactions between engineers and designers of both parties in order to develop a product whose functional and productive specification cannot be entirely defined 'a priori'. JIT supplies require continuous changes and adaptations to production schedules, product packaging and delivery.

According to TCE, in order to protect transaction-specific assets from opportunistic appropriation, and to cope with the effects of exchange uncertainties, buyers will choose to internalize the transaction, or otherwise arrange to increase the extent of hierarchical control over the other party. An exchange structure arises which is an intermediary solution between the integrated manufacturer and the 'market', in that, suppliers and buyers agree to co-operate with one another to form a long-term, co-operative relationship guided by expectations of repeated transactions. This type of relationship is characterized by 'relational contracting'.

Thus, according to TCE theory, when an advanced buyer–supplier operational link is established, the exchange should move from a 'market-based' to 'relational' logic (Williamson 1985, 1991). Anyway, 'relational-exchange' (=long term, exclusive) constitutes a risky alternative to the market, because the buyer becomes more vulnerable to opportunistic behaviour of sources. Furthermore, the sources engaged in a relational exchange escape from direct market competitive pressure: in the long run, this can produce a worsening of their performances.

Both empirical research and theoretical debate exhibit contrasting positions about the advantages of long-term, stable supply relationships, and about the diffusion of a true 'relational' buyer–supplier exchange in western context (Lamming 1990, Helper 1991, Sako *et al.* 1995). Waters-Fuller (1995), following an extensive review of JIT purchasing literature, synthesizes this diversity of positions by comparing two lines of thought: the 'sceptical school' and the 'advocate school'. The first school asserts that exclusivity and longevity are associated to higher switching costs (i.e. lower source replacement possibilities), higher risks of supply disruptions and technological obsolescence. Therefore, the 'cooperative' supply relationship produces an inefficient form of sourcing in the long run.

The second school considers the advantages of JIT sourcing (development of a congruent logistic network with consequent lower inventories, higher delivery reliability, improvements in product quality and delivery lead-times, lower supply management administrative cost, etc.) prevailing over risks. Waters-Fuller mainly refers to the Operations Management literature; nevertheless, the analysis of buyer–supplier operational linkages and their relationships with the exchange governance structure has fostered studies in different research fields (marketing, industrial economics, sociology). In spite of the abundant literature on this topic, few contributions document on an empirical basis the actual evolution in buyer–supplier relationships, especially through comparative analysis, whether by cross-national comparison of industrial change or sectoral transformation (Imrie and Morris 1992). In addition, most of the studies show only anecdotal evidence and qualitative analysis (Kalwani and Narayandas 1995). Much still remains unexplored, e.g. have traditional supply management practices been substituted by more cooperative approaches, in particular in those industries in which strong operational buyer–supplier inter-dependencies can significantly improve the system performances? What is the real extent of this change? What kind of relationships are more likely to lead to good performances? (Helper 1991).

Summarizing, advanced operational buyer–supplier interaction practices, like those promoted by JIT and TQM approaches, seem to be inoperable under traditional, market-based mechanisms. In fact, they seem to require a substantial change of the basic options of buyer's purchasing strategy (supplier selection criteria, number of sources, time horizon of the supply relationship). This change, however, is difficult to implement: on one hand it can potentially improve the performances of the supply system, on the other hand it appears to be difficult to govern being vulnerable to opportunistic behaviour and presenting several other risks (table 1) Therefore, the forms under which this change develops are topics of crucial, though not recent, interest and still remain an open question.

2. The hypotheses

This study considers the three main operational buyer–supplier links (De Toni and Nassimbeni 1995, Nassimbeni 1996):

- *Design link*. This consists of the involvement of suppliers in buyer's product development activities. The competitive necessity to shorten the product life, to enhance the frequency of new product launches, and the need to incorporate into new products higher content of technology have promoted a quick diffusion of this practice in many industries (Lamming 1990). Several empirical observations have demonstrated the benefits of collaborating with suppliers at the product/process design and development stages: reduction in development costs (early availability of prototypes, consistency between design and supplier's capabilities, reduced engineering changes), improvement in product quality, reduction in overall development time (due to early identification of the supplier's technical problems), and the possibility of incorporating innovations suggested by the supplier (Clark 1989, Clark and Fujimoto 1991, Turnbull *et al.* 1992);

Spot market	Relational contracting
Elements • Supplier selection based on price • Multiple sourcing • Spot transactions (short term relationships)	Elements • Supplier selection based on multiple criteria • Single sourcing or reduced supply base • Long-term relationships
Disadvantages • Difficulty (or impossibility) to boost the supplier to the acquisition and development of relational-specific assets → difficulty to generate joint product or innovation → difficulty in the supply of components tailored for the buying firm's production process → difficulty to improve the productive and logistic chain (by means of: adoption of compatible and interacting production planning system, proper packaging procedures, and compatible identification (bar-coding) systems, etc.) • Higher variability of purchased materials • Incompatibility with the 'continuous improvement' and TQM perspectives • Exposure to operational inefficiencies (= necessity of buffer inventories to face supplier's unreliability, need or receiving inspection on entry flows, greater planning time horizons, etc.) • Superior supplier's rigidity to customer's requirements (concerning quality, volumes, deliveries, etc.) • Superior risk of contentious on quality, quantity and time requirements and superior risk of price re-negotiations	**Disadvantages** • Superior risks of unilateral reinforcement (empowerment) of the partner which can stimulate opportunistic behaviour • Higher switching costs and higher source replacement problems—higher dependency from the sources • Higher buyer's operational vulnerability • Higher insensitivity towards the evolutionary trends in the supply markets • More complex and expensive supplier selection

Table 1. 'Spot market' and 'relational contracting': elements and disadvantages.

- *Logistic link*. This is accomplished when the supplier's deliveries are frequent and therefore small-lot sized, perfectly respondent to the buyer's quantity and quality requirements, rigorously synchronized with the buyer's production schedules. The logistic link supports the implementation of Just-in-Time, whose basic elements are: production flow pulled by the market, reduction of any kind of waste, reduction or elimination of inventories so that the production flow can progress without interruptions. The complete implementation of the JIT approach requires the strong support of sources: without de-coupling elements between the (internal and external) production units, a tight integration and synchronization between the order contracting, scheduling, delivering activities is needed between those units. The advantages of the JIT approach are several: lower throughput time, lower inventory costs, easier problem identification, superior efficiency and efficacy of the production chain (Schonberger and Gilbert 1983, Ansari and Modarress 1987, 1990). Nevertheless, the JIT link renders the customer more vulnerable to delivery un-reliability, thus requiring the selection and development of an adequate pool of suppliers;

- *Quality link*. This is accomplished when the buyer and supplier exchange information concerning quality aspects (joint definition of quality specifications, transmission of quality tests and charts, transfer of statistical process control data). This kind of link usually constitutes a pre-requisite for the implementation of the logistic one, since the direct supply of the production line (free pass deliveries) and the elimination of material buffers are possible only if the quality of the supplies is consistently high. However, the need to certify the suppliers and exchange information with them on quality can occur even for materials that are not supplied on a JIT basis. In other words, these quality interaction practices have a value which is partly independent of the presence of a logistic link between buyer and supplier.

On the basis of empirical research on a sample of Italian plants, this study:

- analyses the relationships between advanced buyer–supplier operational interaction practices (design link, logistic link, quality link) and the basic option of the buyer's sourcing policies, e.g. sources selection criteria, supply base reduction policies, long-term perspectives (stability of procurement) granted to suppliers;
- compare those operational interaction practices and sourcing policies in different performing plants. In other words, this study verifies if the buyer–supplier interaction practices and 'cooperative' sourcing policies examined exhibit a predictive validity of the plant performances.

The underlying hypothesis, which summarizes all the detailed hypotheses which will be presented in the next section, is that the development of an operational link between buyer and supplier modifies the buyer's sourcing policies, in particular basic choices:

(1) Which supplier to select? (selection criteria);
(2) How many suppliers to utilize? (number of sources);
(3) What kind of relationship (short or long term) to develop with sources? (procurement stability).

2.1. *Selection criteria*

The traditional supply relationship is 'price-dominated': price is the dominant sources selection criteria in the 'arm's length' approach. The limitations of this approach are essentially two.

First, price is only a component of the actual total procurement cost: delays, qualitative or quantitative unreliability, packaging modes, post-sales assistance are examples of cost elements which are usually not included in the purchasing price (Macbeth 1990, Willis and Huston 1990). Second, a traditional 'price-dominated' relationship reduces the source selection to the choice of a single economic parameter and encourages a limited uni-dimensional improvement.

It is largely argued that the development of an advanced operational link with sources generates the need for multi-dimensional sources evaluation and enhances the importance of 'non-price' selection criteria (Willis and Huston 1990, Weber *et al.* 1991). In fact, the buyer needs sources able to sustain a more qualified and involving interaction, i.e. suppliers endowed with those design, production/logistic and quality relational skills required by new approaches. In addition, an accurate multi-dimensional rating can reduce the 'contractual hazard' associated with the possible buyer specific investment (Christy and Grout 1994). Finally, according to transaction cost theory, supplier evaluation and monitoring constitute a rational control instrument over the supplier's behaviour: in the absence of market-based control mechanisms, an accurate rating system can restore a competitive pressure inside the pool of suppliers by monitoring and comparing the suppliers improvement over time.

The sources selection criteria are often discussed in the literature. Inman (1990), Helper (1991) and Weber *et al.* (1991), to mention just a few contributions, point out the importance of the factors which influence the material flow progress (e.g. quality, delivery reliability, packaging) for vendor selection when the firm decides to implement JIT programmes. Cole (1988), and Willis and Huston (1990) underline the significance of parameters, such as R&D capabilities, design (CAD, CAM) and management systems adopted, as well as some intangible attributes (e.g. managerial philosophy or the quality of management). In the literature, the growing importance of economical/financial aspects like selection criteria is also pointed out: when the buyer–supplier exchange is outlined on a long-term basis, buyers look for suppliers presenting adequate structural solidity and able to invest in the relationship.

The first hypothesis can be expressed in these terms:

H1a. The weight given to price in the source selection is negatively correlated to the buyer–supplier operational link;
H1b. The weight given to 'non-price' factors in the source selection is positively correlated to the buyer–supplier operational link.

2.2. *The number of sources*

Among sourcing decisions, the advantages and disadvantages of single/multiple sourcing choices are probably the most discussed in the literature.

Multiple sourcing (for each purchased part) avoids the buyer's dependence from a single supplier, reducing material stock outrisks and permitting wider supply market monitoring (Kekre *et al.* 1995). In addition, the presence of multiple supplying alternatives enhances the buyer's bargaining power: through the comparisons of different supplying offers the buyer can reduce possible information asymmetries and stimulate a competitive pressure among the pool of sources. In this way, the buying firm reduces non-selection or source's opportunistic behaviour risks (Seshadri *et al.* 1991). On the other hand, multiple sourcing increases the administrative costs of procurements and, more in general, the total cost of transactions (distinct operators sustain the same costs, i.e. production planning and machinery set-up costs). Furthermore, order splitting can impede the achievement of scale-economies, in particular when the supply is complex and can be rewarded only by adequate volumes (Newman 1988). Also, multiple sourcing can impede the qualitative uniformity of supply flows (Richardson 1993).

Thus, multiple sourcing implies advantages and disadvantages. Several authors argue that modern buyer–supplier design and logistic interaction renders its recourse difficult to achieve (Bache *et al.* 1987, Ansari and Modarress 1990, Lyons *et al.* 1990, Turnbull *et al.* 1992). JIT deliveries coming from different multiple sources seem to involve logistic integration, production planning, quality homogeneity and time synchronization problems. Similarly, co-design seems to permit the participation of only a few suppliers, and the earlier (=nearer to product concept) their involvement in the product development activities, the more difficult it is for the buyer to maintain different procurement alternatives.

Also, the specific investments required by the operational link force the buyer to convey his relational resources into a restricted number of supply channels. Helper (1991) observes that "it is costly to establish and maintain extensive communication systems with more than one supplier". In other words, the supplier qualification, development and continuous improvement of a JIT link, and the setting up of compatible communication systems, limit the number of suppliers with whom the buyer can interact.

Notwithstanding the number of contributions, most of the evidence regarding the relationships between modern buyer–supplier interaction practices and supply base reduction policies is based on case-studies (Kekre *et al.* 1995).

Our second hypothesis is therefore the following:

H2a. The adoption of supply base reduction policies is positively correlated to the buyer–supplier operational link.

Assuming that the establishment of a buyer–supplier operational link is associated to the reduction of the number of sources, a major point of discussion then regards the entity of that supply base reduction, i.e. the adoption of single-sourcing practices.

Some authors hold that single-sourcing is important for the realization of a JIT link with the suppliers (see Hall 1983, Treleven 1987). Others maintain that the competition among suppliers, even if restricted to a selected group of sources, is of critical importance if the costs are to be kept low and the quality of the supplies raised (Imrie and Morris 1992, Turnbull *et al.* 1992). A further hypothesis is then the following:

H2b. The adoption of single-sourcing policies is positively correlated to the buyer–supplier operational link.

2.3. *The long-term perspective*

We refer here to the expected length of the exchange relationship, rather than to the formal length of the contract. In the supply system of the Japanese automotive industry, e.g. contracts are usually annual even if the relationship is generally highly stable and contracts are tacitly renewed (McMillan 1990, Cusumano 1991, Fruin 1992, Nishiguchi 1994).

The importance of long-term supply relationships has been debated according to several theoretical approaches.

According to the TCE theory, the time horizon of the relationship depends on the kind of exchange. When the exchange is characterized by specific investments, a failure of the traditional market-based ('spot transaction' where price is the main contracting element) will arise for two basic reasons (Williamson 1985, 1991). First, because the specific investment can be justified only for medium- to long-term supply relationships. Second, because the party which carries out the specific investment is exposed to the risk of opportunistic behaviour by the other party. This happens, e.g. when the buyer decides unilaterally to lower the price of supplies once the supplier has made specific investments, thereby becoming dependent on the buyers itself. Thus, only the expectation of stable (long-term) relationships provides the incentive for specific investment and mitigates the risks of opportunistic behaviour. As discussed in the previous section, the operational interactions considered in this study (on design, logistic and quality) are associated with several kinds of assets specificity.

Game theorists also argue that the perspective of repeated games promotes collaborative behaviour, since future interaction permits one player to sanction or reward the other depending on his past conduct (Axelrod 1984).

Operation management theorists, in particular those belonging to JIT-purchasing field, argue that long-term relationship is a necessary requisite of the JIT system. Only the long-term perspective permits the continuous improvement logic to fully develop by benefiting learning and relationship-specific scale effects. Anyway, most of the studies focused on the relationship between the time horizon of the exchange and the JIT practices exhibit qualitative analysis (Kalwani and Narayandas 1995).

The third hypothesis can be expressed in these terms:

H3. The adoption of long-term sourcing policies is positively correlated to the buyer–supplier operational link.

2.4. *The impact on performances*

Table 1 summarizes possible advantages and disadvantages of the traditional and cooperative buyer–supplier exchange. As the table shows, the reasons for both the 'sceptical school' and the 'advocate school' are numerous. Thus, only empirical evidence can decree the performance superiority of one model over the other. Unfortunately, as Zaher and Venkatraman (1995) observe, investigating the performance implications of the different exchange governance structures is another important gap in current research.

This study has therefore analysed the relationships between: buyer–supplier operational (design, logistic, quality) interaction practices, buyer's sourcing policies and plant performances.

The corresponding hypothesis is the following:

H4. Better performing plants exhibit higher use of advanced buyer–supplier operational practices and cooperative sourcing policies.

Figure 1 summarizes the four hypotheses of the study.

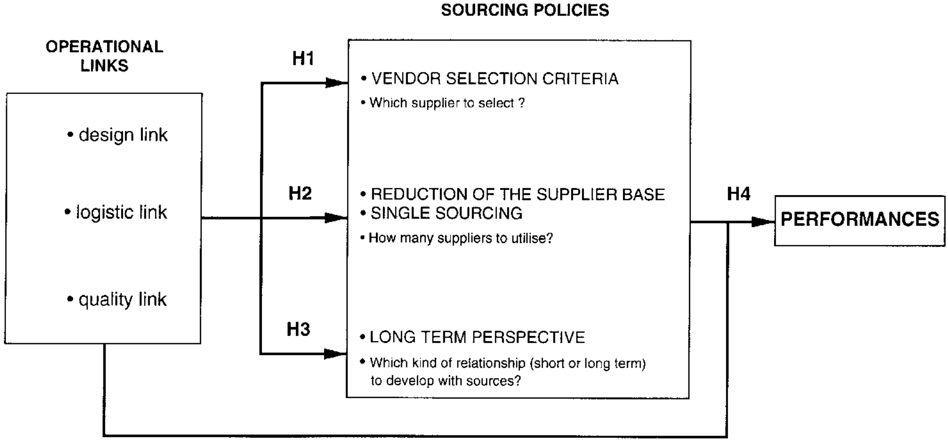

Figure 1. The model

3. Methodology

To test these hypotheses, a survey was carried out using structured questionnaires sent to a sample of 52 Italian plants. The methodological steps are summarized in the following paragraphs.

3.1. *Research approach*

We chose the buyer's plant as the unit of analysis, since the JIT-P practices analysed are implemented at the plant level. The sample was selected at random from plants employing more than 100 people, and was stratified into 'traditional' and 'world class reputation' plants. By 'world class reputation', we mean those which are reputed to have higher than average performances in the sector. 'Traditional' plants were selected from the Kompass (1992) list of firms belonging to the two sectors, and 'World Class Manufacturing' (WCM) plants from a master list compiled using experts in industry as source (consultants and managers). The sectors analysed are those of electronics and machinery in which JIT implementation and the interaction with the suppliers are competitive variables of increasing importance (Gilbert 1990).

First, the plant managers were approached by letter. Then, they were contacted by phone to explain the aims of the study in greater detail and ask whether they were willing to cooperate. Finally, the plants that had agreed to take part were visited to gather qualitative information and establish direct personal contact. This contact strategy resulted in a high response rate: 60% of the plants approached were involved in the survey. An internal research coordinator was then appointed to each plant. His job was to supervise the administration and collection of the questionnaires.

The data and their elaboration refer to a sample of 52 units, 25 in the electronic and 27 in the machinery sectors. The principal characteristics of the sample are reported in table 2.

	Mean (entire sample)
• Sales (millions $)	88.2
• Incidence of purchase on sales	48.3%
• Number of employees	613
Production process:	
• one of a king	20.2%
• small batch	40.4%
• large batch	20.8%
• semi-repetitive	27.2%
• repetitive	1.7%
Kind of products:	
• highly customized	31.2%
• somewhat customized	17.9%
• standard with custom options	29.8%
• somewhat standardized	25.6%
• highly standardized	7.7%

Table 2. Characteristics of sample plants.

3.2. *Measurement*

Prior research was reviewed to identify existing measures of the practices analysed. When available, existing measures were then adapted to facilitate their use in this study. For non-existing measures, new ones were then developed using five-point Likert-scales; the score of multi-item scales was determined as the non-weighted mean of the values of each single item. The constructs were articulated in a sufficient number of items to cover the domain of content of each attribute examined and to limit the influence of random errors in measurements. The initial version of each scale was reviewed together with three plant managers. In this phase, the operationalization process of each practice was tested and the wording of questions was simplified. The items of each scale were spread out through the questionnaires to prevent respondents from becoming aware of the concept behind the questions and so furnish distorted information. Likert-scale questions were addressed to at least three respondents (and thus figure in at least three questionnaires). The greater part of these questions was addressed to the Purchasing, Plant and Production Managers. Some of the questions were also directed to the Quality Manager, Process Engineer, Information System Manager, two supervisors and four workers to make a total of 12 respondents per plant. In all, 497 respondents were involved. There were potentially two types of non-respondent bias: in the sample design and level of inter-rater reliability for respondents in the same plant. To test for possible non-response biases in the sample design, we compared respondent and non-respondent plants according to their annual sales, number of employees, and number of facilities (statistics available in Kompass 1992). All the *t*-tests for differences in respondent and non-respondent means were insignificant at the 5% level of confidence. To test the inter-rater reliability for respondents in the same plant, a one-way analysis of variance was performed for each of the measures comparing within-plant differences with between-plant differences. All measures exhibited significantly greater between-plant variation than within-plant variation. According to Georgopoulos (1986), under such conditions it is correct to aggregate data at the higher level of aggregation and the constructs were calculated using the mean of the respondents' scores.

The operationalization choices are reported in the following.

- *Design, logistic, quality link*. Existing measures were identified in the works of Sakakibara *et al.* (1993), and Flynn *et al.* (1994). Other measures were developed and validated in previous research work of the authors (De Toni and Nassimbeni 1995, Nassimbeni 1996). Eleven practices were measured: 'Information exchange concerning the product', 'Information exchange concerning the production process', 'Information exchange on quality', 'Supplier involvement in product development', 'Supplier quality certification', 'Free pass for deliveries', 'Pull (kanban) procurement approach', 'Deliveries synchronization', 'Integrated production planning', 'Shared production forecasts', 'Packaging congruence'. Many of these practices were found to be strongly correlated to each other. Therefore, a factor analysis (principal component method with varimax rotation) was carried out on these measures. Employing factor scores in the regression model is preferred by researchers and practitioners, as it eliminates concerns about multi-collinearity and leads to efficient estimates (Lehmann 1985). Factor analysis was therefore carried out to uncover the underlying dimensions between the measures, eliminate problems of multicollinearity between them and ultimately reduce the number of variables to a limited number of orthogonal factors (Dillon and Goldstein 1984). Orthogonal factor rotation (factors with eigenvalues greater than 1 were included) locates three main factors: (i) a factor (called 'logistic link'), in which the practices of 'deliveries synchronization', 'integrated production planning', 'shared production forecasts' (blanket purchase orders), 'packaging congruence', and 'pull (kanban) procurement approach' converge; (ii) a factor (called 'design link') in which the practices 'information exchange on product', 'supplier involvement in product development' and 'information exchange on process' converge; (iii) a factor (called 'quality link') in which the practices of 'information exchange on quality', 'free pass deliveries', 'supplier quality certification' converge.

- *The supplier selection criteria.* We have evaluated the weight given by the purchasers to the main supplier selection criteria: price, quality, delivery reliability, technological-productive expertize, economic-financial solidity. On a five-point Likert scale, the purchasing manager specified the importance (weight) given to each of these selection parameters. The variable 'importance of non-price selection criteria' was calculated as the mean of the scores given to the four non-price criteria. A similar approach to the measurement of these constructs was used by Cusumano and Takeishi (1991), and Helper (1991).
- *The number of sources.* In the sample examined, the extension of JIT programs to procurement activities began in recent times (five years on average). We have therefore evaluated the variation of the number of sources in the last four years, weighting it on the variation of the purchases expenses. Alongside this objective measure, we used a Likert scale to evaluate the presence of supplier base reduction policies. As far as concerns single-sourcing policies, we evaluated the variation in percentage of the number of single sources and the variation in percentage of the value of purchases coming from single-sources over a period of four years.
- *Long term perspective.* To operationalize this construct, we used an approach similar to that adopted by Provan and Gassenheimer (1994), and Gundlach *et al.* (1995), who measured the 'long term perspective' through the supplier support and assistance initiatives set in motion by the buyer. In fact, due to the intrinsic incompleteness of the supply contract, its formal length does not represent a significant indicator of the 'long term perspective'. Instead, supplier support and assistance initiatives generally determine investment not recoverable in case of switching, therefore testifying in a clearer way the buyer's true cooperative willingness (the formal length of contract was in any case measured: its absolute value and that weighted on the product life-cycle exhibited an high variance and was uncorrelated to all the other measures). On a five-point Likert scale, respondents specified the intensity of the technological and managerial assistance provided to main suppliers.

Since the buying policies depend, among other factors, on the kind of purchased parts, most of the questions refer to parts characterized by high value use (=volume of purchased parts * unit value). In this way, we have excluded from the analysis suppliers of non-critical parts [cfr Kraljic matrix (Kraljic 1983)], and therefore not involved by the perspective of cooperative exchanges with buyers.

Besides the above-mentioned measures, we used as control measures the plant dimensions (evaluated through the annual value of production), the industry (evaluated through a dummy variable, where 0 = electronic industry and 1 = mechanical industry) and the main production typology (another dummy variable, where 0 = lot production and 1 = repetitive/continuous production), following an approach similar to that of Lawrence and Hottenstein (1993). We introduced these variables in order to verify if bigger plants are more likely to develop a logistic or design link with sources (given the presumably larger amount of their inventories and the higher value of their products), and are facilitated in developing stable and more exclusive relationships with sources (given the presumably higher structural solidity and the larger amount of purchases). Also, we intended to verify if repetitive productions, requiring higher stability of inputs, would get a greater benefit from long-term and exclusive supply relationship. Finally, we were interested to see if there were differences between the two industries analysed. These control measures were substantially uncorrelated to the other measures. Therefore, the results obtained can be considered independent from those environmental aspects.

3.3. *Validation of the measurement instrument*

All measures were subjected to:

- Reliability assessment, operationalized as internal consistency of the item on each scale. Cronbach's alpha (Zeller and Carmines 1980) was calculated for each scale. All the constructs have an alpha value greater than the cut-off value (0.6) that is suggested as acceptable (Nunnaly 1978).
- Validity assessment. Content validity was verified through a review of the literature, the theoretical revision used by the authors, and a comparison with some managers of the firms sampled. Construct validity was verified by using factor analysis to test the uni-dimensionality of multi-items measures. In order to guarantee the convergence of all items of each scale to a common unique factor, items were dropped unless the scale had a minimum eigenvalue of 1.00 and each item factor loading was greater (in absolute value) than 0.40 (Kim and Mueller 1978). The scales showed high validity, and only in certain cases did the existence of more than one underlying dimension lead to the elimination of certain items.

Table 3 summarizes the measurements used, their mean, standard deviation, reliability coefficient and operational definition. Table 4 provides the results of the factor analysis, showing the rotated matrix of factor loading.

4. Results and discussion

Hypotheses H1–H3 were verified using regression analysis, assuming the three operational (design, production-logistic and quality) links as independent and the three sourcing policies (supplier selection criteria, supplier base reduction and long-term perspective) as dependent variables. Regression analysis is the correct statistical technique when investigating the relationship between a dependent variable and a set of independent variables (Dillon and Goldstein 1984). Before using this technique, we verified that our data met the basic assumption of normality, homoscedasticity and linearity. Table 5 reports the results of the regression analysis.

- *Hypothesis 1.* H1a is rejected: any significant relationship emerges between the importance of price in supplier selection and the three operational dimensions. In fact, the adjusted squared multiple correlation coefficient ($R^2 = 0.009$, table 5)

Measures Sourcing policies	No of items of the construct[a]	Mean	Standard deviation	Cronbach alpha	Operationalization
• Importance of price in supplier selection	1	4.58	0.65	—	Evaluates the weight given to price in the selection of the main suppliers
• Importance of non-price selection criteria [adapted from Helper (1991), and Cusumanoa nd Takeishi (1991)]	4	4.12	0.50	0.73	Evaluates the weight given to quality, deliveries reliability, technological-productive expertize, economic-financial solidity in the selection of the main suppliers
• Supplier base reduction	—	9%	29%	—	Determines the variation (in percentage) of the number of sources in the last four years, weighted on the variation of the purchases expenses
	3	3.46	1.04	0.93	Evaluates if the firm has adopted supply base reduction policies during the last years
• Single sourcing	—	23.0%	12.2%	—	Determines the variation in percentage of the number of single sources and the variation in percentage of the value of purchases coming from single-sources over a period of four years
• Long term perspective [adapted from Provan and Gassenheimer (1994), and Gundlach *et al.* [1995])	2	2.78	0.89	0.71	Evaluates if the buyer testifies his co-operative willingness through assistance and training initiatives provided to main suppliers.
Operational link					
Design link					
• Information exchange concerning the product (Nassimbeni 1996)	3	3.59	0.77	0.82	• Surveys the intensity of the information exchanged during the product development activities regarding the products and component to be supplied, and the choice of materials
• Information exchange concerning the production process (Nassimbeni 1996)	3	3.01	0.83	0.90	• Surveys the intensity of information exchanged regarding production cycles, process and tools used
• Supplier involvement in product development [adapted from Sakakibara *et al.* (1993)]	4	3.26	0.86	0.84	• Evaluates the nature and intensity of the main supplier's involvement in product development activities
Logistic link					
• Deliveries synchronization [adapted from Sakakibara *et al.* (1993)	3	2.92	0.66	0.66	• Evaluates if the deliveries are frequent and in small lots
• Integrated production planning (Nassimbeni 1996)	3	3.43	0.87	0.70	• Evaluates if the internal production planning system is integrated with that of the main suppliers
• Shared production forecasts [adapted from Sakakibara *et al.* (1993)]	—	29.7%	35.0%	—	• Evaluates the percentage of purchasing (value) via blanket purchase orders
• Packaging congruence [adapted from Sakakibara *et al.* (1993)]	3	3.05	0.83	0.76	• Detects if the packaging used by the main suppliers meets specific requirements and is consistent with the loading and handling requirements of the plant.
• Pull (kanban) procurement approach [adapted from Sakakibara *et al.* [1993])	3	2.24	0.91	0.96	• Evaluates if there is a 'kanban/pull system' in the plant, and between the plant and the suppliers
Quality link					
• Information exchange concerning quality [adapted from Flynn *et al.* (1994, 19950]	4	3.66	0.71	0.85	• Evaluates the availability and use of information concerning the quality of the materials, the results of of quality tests and trials carried out by the supplier, statistical process control data from suppliers of critical parts
• Free pass for deliveries [adapted from Sakakibara *et al.* (1993)]	—	15.7%	28.3%	—	• Determines the variation (in percentage) of the incoming materials (value) accepted for use in manufacturing, without inspections, evaluated over the last four years
• Suppliers quality certification [adapted from Flynn *et al.* (1994, 1995)]	3	3.35	0.73	0.70	• Detects if the plant uses certified suppliers

[a] Only for Likert scales.

Table 3. Summary of measures.

	Factor 1	Factor 2	Factor 3
• Deliveries synchronization	0.8267	0.1910	0.1667
• Integrated production planning	0.7273	0.1884	−0.2286
• Shared production forecasts (blanket orders)	0.7145	0.2416	0.1467
• Packaging congruence	0.6928	0.4236	−0.1543
• Pull (kanban) procurement approach	0.6628	0.3181	0.2734
• Information exchange on produce	0.1931	0.9055	0.0958
• Supplier involvement in product development	0.2490	0.8098	0.2575
• Information exchange on development process	0.2474	0.5088	0.1408
• Information exchange on quality	0.0027	0.0499	0.9147
• Free pass for deliveries	0.2234	0.1158	0.7069
• Supplier quality certification	0.1133	0.3305	0.6521
Eigenvalues	4.16	1.94	1.04
Percentage of total variance explained by rotated components	37.9%	17.7%	9.5%

The leading coefficients are underlined.

Table 4. The rotated factor matrix.

and the *F*-test ($P = 0.468$ in the multivariate test) are unsignificant. Instead, the analysis shows a significant relationship between the importance of non-price factors in supplier selection and the three operational dimensions ($R^2 = 0.119$, $P = 0.032$). Therefore, H1b is accepted. In this case, however, only the design link shows a significant relationship ($P = 0.006$) with the dependent variable.

- *Hypothesis 2*. H2a is accepted: a significant relationship exists between supplier base reduction policies and the set of the three independent variables ($R^2 = 0.120$, $P = 0.027$). Also in this case, however, only the design link is significantly related to the dependent variable ($P = 0.006$). Hypothesis H2b is instead rejected ($R^2 = 0.033$, $P = 0.222$): the development of any of the three operational links examined is accompanied by the recourse to single sourcing policies.
- *Hypothesis 3*. Hypothesis H3 is accepted: a long-term perspective is significantly related to the establishment of an advanced operational link with

	Importance of price in supplier selection	Importance of non-price selection criteria	Supplier base reduction	Single sourcing	Long term perspective
Hypotheses	1a	1b	2a	2b	3
adjusted R^2	0.009	0.119	0.120	0.033	0.396
F	0.862	3.199*	3.345**	1.521	11.930***
Significance of *F*	0.468	0.032	0.027	0.222	0.000
Independent variables					
• Design link	b = 0.131	b = 0.386**	b = 0.389**	b = 0.019	b = 0.298**
	P = 0.380	*P* = 0.006	*P* = 0.006	*P* = 0.897	*P* = 0.009
• Logistic link	b = 0.195	b = 0.049	b = 0.201	b = 0.268	b = 0.513***
	P = 0.1949	*P* = 0.711	*P* = 0.151	*P* = 0.0688	*P* = 0.000
• Quality link	b = 0.038	b = 0.147	b = 0.072	b = 0.146	b = 0.285*
	P = 0.799	*P* = 0.280	*P* = 0.602	*P* = 0.315	*P* = 0.013

b: Standardized regression coefficients.
P: Significance: *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

Table 5. Results of the regression analysis.

sources ($R^2 = 0.396$, $P = 0.000$). Each of the three independent variables is significantly associated to the dependent, but at different intensities. The logistic link shows the strongest relationship ($P = 0.000$), followed by the design link ($P = 0.009$) and the quality link (0.013).

The results of the statistical analysis point out two main elements of discussion. The first element concerns the relationship between the sourcing policies and the overall set of operational links examined. The second element consider the relationship between the sourcing policies and each single operational (design, logistic, quality) link.

As far as the first element is concerned, the following results emerge:

- among the sourcing policies analysed, three variables ('importance of non-price selection criteria', 'supplier base reduction' and 'long-term perspective') are significantly correlated to the presence of an operational link with suppliers. The variable 'long-term perspective' shows the highest ($P = 0.000$, table 5) relationship;
- two other variables ('importance of price in supplier selection' and 'single sourcing') are not significantly related to the operational links examined. Evidently, when developing an advanced operational link with sources, the buyer reduces the supplier base avoiding, however, a total exclusive rapport. Similarly, if non-price factors assume higher importance when an operational link arises, the weight given to price does not show any significant changes. Thus, price still continues to play an important role (average value = 4.58 in corespondent five-point Likert scale—table 3).

Summarizing, the establishment of design, logistics or quality interactions with sources modifies the buyer's sourcing options, imposing an exchange government structure different from the 'market-based' one. However, such a change does not foresee single sourcing practices and the denial of price-related factors in supplier selection, i.e. the elements (besides the long-term perspective) which ideally characterize the cooperative buyer–supplier relationship. Going back to the cited bibliographic review of Waters-Fuller (1995), these results partially contradict those authors who argue that "firms tend to implement the easier aspects of JIT sourcing". Among the JIT practices more difficult to implement, Waters-Fuller lists: the 'long term contracts', 'data exchange' and 'sole sourcing'. This survey instead shows that the buyer's willingness to establish a stable, long-term relationship with the integrated supplier is witnessed, even if not by formal long-term agreements, by assistance and training initiatives. As far as single sourcing is concerned, our data confirm that it does not accompany the establishment of an operational link with sources. We do not believe (as Waters-Fuller does) that this result demonstrates the difficulties of buyers in implementing the most radical elements of JIT sourcing. Rather: we believe that it demonstrates the search for a compromise between two needs. On one hand, the buyer needs to give up the traditional 'market-base' supply management. On the other hand, the buyer needs to avoid the risks of excessive dependence on sources.

The second element of discussion concerns the relationship between the sourcing policies and each single operational (on design, logistic, quality) dimensions. The following results emerge:

- the quality link reveals a less committed buyer–supplier interaction. It is associated with a long-term perspective ($P = 0.012$, table 5), but is not accompanied by supplier base reduction policies or clear valorization of non-price supplier selection criteria. Evidently, the importance of quality in the present competition has determined a wide diffusion of TQM practices almost at each step of the supply chain. Therefore, the ability to adequately interact with the buyer about quality-related topics is now an indispensable component of the supply offer, rather than a differentiation element;

- comparing the design and logistic link, we discover that only the design link is associated to supplier base reduction policies and to a supplier selection which emphasizes non-price criteria. Both links instead play a significant role in committing the buyer to a long-term relationship. In general, the empirical evidence shows that the design link is generally more exclusive and binding than the logistic link. Possible justifications are:
  - the collaboration in product development implies more intensive personnel interactions, and a higher exchange of proprietary product and process technology information. Therefore, it is a link which presents higher exclusivity requirement (= supplier base reduction);
  - the design link is more customer-oriented (it requires a more customized contribution). In fact, specificities concerning product and process, involving technologies and materials, seem to be wider than those concerning the production-logistic process, i.e. concerning only the timing and frequency of procurement rather than the object of supply. Because of the higher specificity of his contribution, the supplier involved in co-design activities is in general more difficult to replace (= lower supplier turnover). For the same reason, the design interaction is more difficult to define ex-ante and measure ex-post. Thus, the buyer is more vulnerable to supplier opportunistic behaviour. A more intensive supplier selection effort (= higher attention to non-price factors) is therefore required.

- *Hypothesis 4*. Before testing H4, a preliminary analysis was conducted in order to verify the statistical difference between the two sub-samples ('traditional' and 'WCM' plants) in terms of performance. The performance indicators selected concern the three main performance dimensions: quality (annual average percent of products returned because of customer dissatisfaction, management's perception on plant quality performances); time (average on-time delivery rate, management perception of plant time performances); cost (inventory turnover, management's perception on plant cost performances). The *t*-tests for equality of means in 'traditional' and 'WCM plants' generally show a significant statistical difference (with an interval of confidence of 95%) between the two sub-samples.

  Discriminant analysis was then utilized to compare the use of the operational practices and sourcing policies analysed in low and high performing plants. This analysis is the correct statistical technique for classifying the units of analysis into mutually exclusive groups on the basis of a set of independent variables (Dillon and Goldstein 1984). In our case, the dependent categorical variable corresponds to which plant group each plant belongs to ('traditional' and 'WCM' plants), while the independent variables correspond to the three operational links (design, logistic and quality) and the five sourcing options ('Importance of price in supplier selection', 'Importance on non-price selection criteria', 'Supplier base reduction', 'Single sourcing', 'Long term perspective').

Discriminant analysis was used considering the two sets of independent variables (operational practices and sourcing policies) separately, in order to avoid multicollinearity problems between the two sets. The results are reported in table 6, which shows the mean and standard deviation in the two groups ('traditional' and 'WCM' plants), and the significance and standardized discriminant coefficient of each of the predictor variables (the five sourcing variables and the three operational links which, by construction, are standardized, i.e. their mean = 0 and variance = 1). The table also shows the mean and standard deviation in the two groups of the measures composing each operational factor.

The results generally support the hypothesis: the operational links show a clear discriminating effect (multivariate *F*-test: $P = 0.000$, 71.15% of the cases were correctly classified by the discriminant function, table 6), as do the set of the sourcing policies (multivariate *F*-test: $P = 0.009$, 76.74% of the cases were correctly classified by the discriminant function).

As far as the operational links are concerned, better performing plants have more advanced design ($P = 0.004$, table 6) and logistic links ($P = 0.016$) with sources. The quality does not show any discriminating effect ($P = 0.730$).

As extensively argued in the literature, buyer–supplier design and logistics interactions can reduce the product development, production and delivery time, and can improve quality and lower costs. As expected, these results confirm the strong relationship between plant performances and co-design or JIT purchasing logistic practices (e.g. JIT deliveries synchronization under a pull logic, integrated production planning with shared production forecasts and packaging congruence).

Is not surprising that quality interaction does not discriminate on plants. Two of the items used to measure the quality link have values that are among the highest. Thus, the practices regarding the management and control of quality on entry flows are by now widespread: the ever more exacting market demand for quality call these practices to the attention of even the less well performing plants.

As far as the sourcing policies are concerned, only the 'long-term perspective' exhibits a discriminating effect ($P = 0.000$ table 6). It is thus confirmed that the perspective of lasting relationship is a necessary element of partnership: it justifies the transaction-specific investment, allows the 'continuous improvement' logic and mitigates opportunistic temptations. Instead, the importance of price in the supplier selection and the use of single sourcing does not differ in traditional and WCM plants. Therefore, the best performing supply systems (evaluated through their impact on plant performances) are not characterized by total exclusivity of relationship and a supplier selection not governed by price (cost) consideration.

Even if WCM plants show a greater attention to non-price supplier selection criteria, the differences between them and the traditional plant are statistically not significant ($P = 0.234$). Clearly, the diffusion of the multidimensional vendor rating systems still remains limited, with the exception of plants which have developed a design link with suppliers. For these plants, the accurate rating of the supplier technological capabilities is presumably crucial.

Finally, the adoption of supplier base reduction policies does not discriminate on plant either. However, it should be noted that the average number of sources of the sampled plants has been globally lowered over the last four years by 9%. Therefore, the attention towards leaner supply structures is in any case widespread.

	Mean		Standard deviation			
	'Traditional' plants $n = 30$	'WCM' plants $n = 22$	'Traditional' plants	'WCM' plants	Univariate F-statistics	Standardized discriminant coefficient
Operational links						
• Design links	−0.412	0.543	0.925	0.835	$P = 0.004$	0.878
• Information exchange concerning the product	3.320	3.947	0.727	0.682		
• Information exchange concerning the product process	2.703	3.439	0.821	0.634		
• Supplier involvement in product development	2.969	3.657	0.864	0.609		
• Logistic link	−0.302	0.399	0.901	1.003	$P = 0.016$	0.687
• Deliveries synchronization	2.760	3.137	0.581	0.703		
• Integrated production planning	3.133	3.841	0.912	0.629		
• Shared production forecasts	20.0%	41.6%	29.5%	39.5%		
• Packaging congruence	2.646	3.596	0.678	0.694		
• Pull (kanban) procurement approach	1.961	2.627	0.826	0.892		
• Quality link	−0.042	0.056	1.029	0.982	$P = 0.730$	0.103
• Information exchange concerning quality	3.574	3.775	0.765	0.614		
• Free pass for deliveries	8.2%	27.6%	24.4%	33.3%		
• Suppliers quality certification	3.251	3.481	0.843	0.532		
Multivariate F-test: $P = 0.000$ Percent of grouped cases correctly classified: 71.15%						
Sourcing policies						
• Importance of price in supplier selection	4.615	4.545	0.637	0.671	$P = 0.784$	−0.392
• Importance on non-price selection criteria	3.961	4.174	0.558	0.444	$P = 0.234$	0.354
• Supplier base reduction	3.193	3.828	1.066	0.904	$P = 0.217$	0.054
• Single sourcing	−101.8%	190.4%	1208.0%	1243.0%	$P = 0.353$	0.379
• Long-term perspective	2.381	3.333	0.718	0.817	$P = 0.000$	0.912
Multivariate F test: $P = 0.009$ Percent of grouped cases correctly classified: 76.76%						

Table 6. Results of the discriminant analysis.

5. Conclusions

The results of this study raise several issues. First, it is demonstrated that the creation of an advanced link with sources modifies the basic options of the supply strategy of the buyer. In particular, operational inter-dependencies at the design, production-logistic or quality level orientate the buyer towards the long-term, convincing him to invest in integrated sources (e.g. thorough assistance and training). Thus, as predicted by TCE theory, advanced operational buyer–supplier interaction practices, like those promoted by JIT and co-design approaches, seem to be inoperable under traditional, pure market-based mechanisms. These interactions are accompanied by specific investment and higher contractual incompleteness, therefore imposing a long-term perspective to the supply relationship.

Even where there is a strong operative collaboration, however, single sourcing remains an unused policy and price remains one of the principle criteria for monitoring sources. The buying strategy that is created follows a sort of compromise between the need to abandon traditional buying procedures and the need to avoid the dangers of excessive dependence on sources. The 'relational-exchange' constitutes in fact a risky alternative to the market, since the sources engaged in a long-term and exclusive exchange escape from direct competitive pressure and can develop opportunistic behaviour. Thus, the buyer grants the sources a perspective of long-term relationship, which is necessary to justify the supplier's transaction-specific investment and to foster a 'continuous improvement' perspective. The buyer tries in every way to limit the risks of a stable exchange by avoiding a totally exclusive relationship and by monitoring price aspects.

The second important element which arises from the research is that the hypothesized relationship between sourcing policies and buyer–supplier operational link also depends on the latter. Design interaction seems to be the most exclusive and binding form of collaboration. This is presumably justified by the higher specificity of the contribution and the greater difficulty in substituting the sources involved in this form of interaction. Vice versa, the quality link reveals the less committed buyer–supplier interaction: the ability to adequately interact with the buyer over quality-related topics seems at present to be an indispensable component of the supply offer, rather than a differentiation element.

The third element concerns the factors discriminating plants, i.e. the impact of operational practices and sourcing policies on performance. As already noted, this is a crucial topic of debate: the advantages and disadvantages of the traditional and cooperative buyer–supplier exchange are largely discussed in the literature. This study demonstrates that better performing plants exhibit a higher level of design and logistic interactions, and a better use of long-term supply agreements with sources. Thus, co-design and JIT purchasing practices, together, with the stability of procurement, influence plant performance to a significant extent. However, the best performing supply systems do not exhibit total exclusivity of relationship and a supplier's selection not governed by price (cost) considerations, i.e. do not exhibit all the elements which ideally characterize the 'cooperative' approach.

There are various openings for further investigation at this point. The main one concerns a series of aspects which, together with the three sourcing policies considered, complete the description and comprehension of the exchange. Among these aspects are the existence of buyer tools for sanctioning suppliers and acting as an incentive (e.g. policies concerning the increase or decrease of the volume of supplies or number of orders given to the suppliers), the possibility of vertical integration of the parties, and the existence of hostages (e.g. partial property of production instruments). Again, it would be interesting to consider the influence of the buyer's operative system on the relationship investigated: it is possible to hypothesize that the nature of the processes, level of decomposability and measurability (predictability) of productive tasks, and technological features (informative content, codifiability) vary from plant to plant and industry to industry, making the various forms of interaction with suppliers diversely critical. These aspects have not been investigated to a sufficient degree in the literature on buyer–supplier interactions. A dense research agenda is opening on them.

References

Ansari, A. and Modarress, B., 1987, The potential benefits of Just-in-Time purchasing for U.S. manufacturing. *Production and Inventory Management*, **28**, 30–36.

Ansari, A. and Modarress, B., 1990, *Just in Time Purchasing* (New York: Free Press).

Axelrod, R., 1984, *The Evolution of Cooperation* (New York: Basic Books).

Bache, J., Carr, R., Parnaby, J. and Tobias, A. M., 1987, Supplier development systems. *International Journal of Technology Management*, **2**, 219–228.

Christy, D. P. and Grout, J. R., 1994, Safeguarding supply chain relationships. *International Journal of Production Economics*, **36**, 233–242.

Clark, K., 1989, Project scope and project performance: the effect of parts strategy and supplier involvement on product development. *Management Science*, **35**, 1247–1263.

Clark, K. and Fujimoto, T., 1991, *Product Development Performances* (Boston, MA: Harvard Business School).

Cole, G. S., 1988, The changing relationship between original equipment manufacturers and their supplier. *International Journal of Technology Management*, **3**, 299–324.

Cusumano, A. M. and Takeishi, A., 1991, Supplier relation and management: a survey of Japanese-transplant, and U.S. auto plants. *Strategic Management Journal*, **12**, 563–588.

Cusumano, M. A., 1991, *The Japanese Automobile Industry* (Boston, MA: Harvard Business School).

De Toni, A. and Nassimbeni, G., 1995, *Operational and Organisational JIT Purchasing Attributes: Underlying Dimensions and Relationships, Management and New Production Systems*, edited by D. Draaijer, H. Boer and K. Krabbendam (The Netherlands: University of Twente).

Dillon, W. and Goldstein, 1984, *Multivariate Analysis—Method and Applications* (New York: Wiley).

Flynn, B. B., Schroeder, R. G. and Sakakibara, S., 1994, A framework for quality management research and an associated measurement instrument. *Journal of Operations Management*, **11**, 339–366.

Fruin, W. M., 1992, *The Japanese Enterprise System* (Oxford: Clarendon Press).

Gilbert, J. P., 1990, The state of Jit implementation and development in the USA. *International Journal of Production Research*, **28**, 1099–1109.

Georgopoulos, B. S., 1986. *Organizational Structure, Problem Solving and Effectiveness* (San Francisco: Jossey-Bass).

Gundlach, G. T., Achrol, R. S. and Mentzer, J. T., 1995, The structure of commitment in exchange. *Journal of Marketing*, **59**, 78–92.

Hall, R. W., 1983, *Zero Inventories* (Homewood, IL: Dow Jones-Irwin).

Helper, S., 1991, How much has really changed between U.S. automakers and their suppliers? *Sloan Management Review*, Summer, 15–28.

Imrie, R. and Morris, J., 1992, A review of recent changes in buyer-supplier relations. *Omega*, **5**, 641–652.

Inman, R. A., 1990, Quality certification of suppliers by JIT manufacturing firms. *Production and Inventory Management Journal*, Second Quarter, 58–61.

Jackson, B., 1985, *Winning and Keeping Industrial Customer* (Lexington: Lexington Books).

Johnston, R. and Lawrence, P., 1988, Beyond vertical integration: the rise of the value added partnership. *Harvard Business Review*, July–August, 94–101.

Kalwani, M. U. and Narayandas, N., 1995, Long-term manufacturer-supplier relationships: do they pay off for supplier firms? *Journal of Marketing*, **59**, 1–16.

Kekre, S., Murthi, B. P. S. and Srinivasa, K., 1995, Operating decisions, supplier availability and quality: an empirical study. *Journal of Operations Management*, **12**, 387–396.

Kim, J. Q. and Mueller, C. W., 1978, *Factor Analysis: Statistical Methods and Practical Issues* (Beverly Hills: Sage Publications).

Kompass, 1992, *Kompass Italia: General Yearbook of Italian Economy* (Italy: Kompass Italia).

Kraljic, P., 1983, Purchasing must become supply management. *Harvard Business Review*, September/October, 109–117.

Lamming, R., 1990, Strategic options for automotive suppliers in the global market. *International Journal of Technology Management*, **5**, 649–684.

Lamming, R., 1996, Squaring lean supply with supply chain management. *International Journal of Operations and Production Management*, **16**, 183–196.

Lawrence, J. L. and Hottenstein, M. P., 1993, The relationship between JIT manufacturing and performance in Mexican plants affiliated with U.S. companies. *Journal of Operations Management*, **13**, 3–18.

Lehmann, D. R., 1985, *Market Research and Analysis* (Homewood, IL: Richard D. Irwin).

Lyons, T. F., Krachenberg, A. R. and Henke, J. W., Jr, 1990, Mixed motive marriages: what's next for buyer-supplier relations? *Sloan Management Review*, Spring, 29–36.

Macbeth, D. K., 1990, Supplier manegement in support of JIT activity: a research agenda. *International Journal of Production & Operations Management*, **7**, 53–63.

McMillan, J., 1990, Managing suppliers: incentive systems in Japanese and U.S. industry. *California Management Review*, **32**, 38–55.

Nassimbeni, G., 1996, Factors underlying operational JIT purchasing practices. *International Journal of Production Economics*, **42**, 275–288.

Newman, R. G., 1988, Single source qualification. *Journal of Purchasing and Materials Management*, Summer, 10–17.

Nishiguchi, T., 1994, *Strategic Industrial Sourcing* (New York: Oxford University Press).

Nunnaly, J., 1978, *Psychometric Theory* (New York: McGraw-Hill).

Provan, K. P. and Gassenheimer, J. B., 1994, Supplier commitment in relational contract exchanges with buyers: a study of interorganizational dependence and exercised power. *Journal of Management Studies*, **31**, 55–68.

Richardson, J., 1993, Parallel sourcing and supplier performance in the Japanese automobile industry. *Strategic Management Journal*, **14**, 339–350.

Sakakibara, S., Flynn, B. B. and Schroeder, R. G., 1993, A framework and measurement instrument for Just-In-Time manufacturing. *Production and Operations Management*, **2**, 177–194.

Sako, M., Lamming, R. C. and Helper, S. M., 1995, Supplier relationship in the UK car industry: good news–bad news. *European Journal of Purchasing and Supply Management*, **2**, 35–48.

Schonberger, R. J. and Gilbert, J., 1983, Just-in-Time purchasing: a challenge for U.S. industry. *California Management Review*, **26**, 54–68.

Seshadri, S., Chatterjee, K. and Lilien, G. L., 1991, Multiple source procurement competitions. *Marketing Science*, **10**, 246–263.

Treleven, M., 1987, Single sourcing: a management tool for the quality supplier. *Journal of Purchasing and Materials Management*, Spring, 19–24.

Turnbull, P., Oliver, N. and Wilkinson, B., 1992, Buyer-supplier relations in the UK automotive industry: strategic implications of the Japanese manufacturing model. *Strategic Management Journal*, **13**, 159–168.

Waters-Fuller, N., 1995, Just-In-Time purchasing and supply: a review of the literature. *International Journal of Operations and Production Management*, **15**, 200–236.

Weber, C., Current, J. and Benton, W., 1991, Vendor selection criteria and methods. *European Journal of Operation Research*, **50**, 2–18.

Williamson, O. E., 1979, *Markets and Hierarchies: Analysis and Antitrust Implications* (New York; Free Press).

Williamson, O. E., 1985, *The Economic Institutions of Capitalism* (New York: Free Press).

Williamson, O. E., 1991, Comparative economic organization: the analysis of discrete structural alternatives. *Administrative Science Quarterly*, **36**, 269–296.

Willis, T. and Huston, C. R., 1990, Vendor requirements and evaluation in a JIT environment. *International Journal of Operations and Production Management*, **10**, 41–50.

Womack, P. J., Jones, D. T. and Roos, D., 1990, *The Machine that Changed the World* (New York: Rawson Associates).

Zaheer, A. and Venkatraman, N., 1995, Relational governance as an interorganizational strategy: an empirical test of the role of trust in economic exchange. *Strategic Management Journal*, **16**, 373–392.

Zeller, R. A. and Carmines, E. G, 1980, *Measurement in the Social Sciences* (London: Cambridge University Press).