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A measurement instrument
of supplier co-design capability

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Abstract

The article describes a framework for the detailed analysis and measurement of the support given by the suppliers to the buyer's new product development (NPD) activities. The framework proposed is divided into three components: the suppliers technological level, the suppliers capacity for innovation and the suppliers co-design effort. The work in particular develops the third component, which is the most critical in relation to product development performance, but also the most neglected in the literature. The article gives an example of the application of the proposed instrument in an important company in the north-west of Italy which operates in the sector of Industrial Automation.

Introduction

Several studies and empirical observations have demonstrated the benefits of collaborating with the suppliers at the product/process design and development stages [1,2,3,4,5,6]. The contribution of the supplier in NPD can, in fact, enable the buyer to capitalize on the sources expertise within a certain application horizon, to shorten the time to market, to improve the quality and lower the global cost, to increase the level of motivation and responsibility of suppliers, thanks to their “ownership” of the total product design and not just “pieces” of it.

Various investigations have shown that one of the principal reasons for the competitive advantage of the Japanese automotive industry can be found in their original supply system [7,8,9,10,11]. The Japanese assemblers actively involve the suppliers in NPD activities asking for their contribution on almost all the technological aspect of the product. The shearing of designing responsibility and the exchange of information concerning the product has enabled the assemblers to significantly improve time, cost, and quality performance [1,2]. Following the performance of their Japanese competitors, the European automobile makers have imported the co-design approach: the research carried out by Lamming [3] and Turnbull et al. [4] indicate that in the European automotive industry the involvement of the supplier in NPD has become frequent. In spite of the large number of studies on co-design and its spread to an increasing number of industries, in the literature there are few contributions specifically dedicated to the measurement of the suppliers' contribution to NPD.

In this work we propose an instrument for the evaluation of the suppliers' co-design contribution, divided into three components: the supplier's technological level, the supplier's innovation capacity, the supplier's co-design effort. By means of a series of measurements, of a perceptive nature, this work develops the third component, in particular, which is the most critical in relation to the NPD performance, but also the most neglected in the literature. The perceptive questions proposed refer to the principal stages in NPD: product concept and functional design, product structural design and engineering, process design and engineering [1]. Downstream from the NPD activity carried out jointly with the supplier, the

instrument allows the designers of the buyer firm to promptly evaluate the innovative effort made by the suppliers on the new product. It can also permit a more analytical understanding of the mode by which the contribution of the supplier is made, identifying potentialities not yet fully exploited or development stages which require significant improvement.

The evolution of vendor rating systems

The supplier selection problem is perhaps the most important component of the purchasing function. The task of the vendor rating system is precisely that of identifying the suppliers best equipped to respect the customer's expected level of performance, and checking this periodically and systematically [12]. Though its importance has remained unaltered with time, the approach to vendor rating has greatly changed.

In the past the vendor rating systems were depicted according to the “traditional” (“adversarial” or “arm’s length”) approach to supply management activities. In conformity with this approach, past vendor rating systems prevalently measured the supplier’s output on the basis of a few quantitative parameters (percentage of orders that arrive at scheduled time, percentage of items or orders that meet quality requirements, lead time of deliveries, etc.), which were eventually weighted on the basis of the firm’s purchases portfolio (see [13]). Following these parameters the supplier was selected who, respecting the minimal quality and time specifications, offered a better price than the other competing bidders. Generally the evaluations were the responsibility of the Purchasing and Production functions and the results were not communicated to the sources.

Current business trends, including shortened product life cycles, increased rate of technological change, market requirements for higher quality and service, have given rise to a growing trend towards improved communication and cooperation between the two parties, bringing the “traditional” supply management approach into discussion. Supplier involvement in NPD, for example, cannot be managed according to a short-term, price-based, antagonistic logic. Co-design activities need continuous interactions between engineers and designers of both parties in order to develop a product whose functional and design specifications cannot be entirely defined “a priori”. Also, joint NPD needs relational resources distributed over time and matured through the progressively deeper knowledge of the partner's requirements. Therefore, the exchange moves from a “market-based” to a “relational” logic [14], that is long-term and more exclusive.

In this context, the traditional vendor rating systems are shown to be inadequate. The supplier’s contribution to product development is, in fact, a process that cannot be measured in output as it is carried out together with the customer and also depends on the technological profile of the source. Thus it is opportune to evaluate not only what the source supplies but how he develops and manufactures the product. Evaluation becomes the responsibility not only of Purchasing and Production but also of the other functions such as Design or Quality. Besides, being intangible, the co-design contribution of sources cannot be measured by means of objective indicators, but requires a perceptive evaluation of a multiplicity of criteria. In addition the evaluation is oriented not so much towards selection as towards monitoring the suppliers since the choice of the source cannot be made according to a short-term logic and to a bidding competition among a number of suppliers. The criteria are weighed not only according to the purchases portfolio but also according to the life-cycle of the buyer-supplier relationship and the synthetic evaluation often utilizes multi-criteria methodologies. Finally, in a prospective of “continuous improvement”, the evaluation must be transparent so that the suppliers may know their limits and make needed improvements.

Thus, in respect to the past the present vendor rating systems measure the supplier's profile, not only his output. They use perceptive measures, not only objectives ones, employing weights differentiated according to the life cycle of the relationship, not only depending on the purchases portfolio. Present vendor rating systems require the contribution of different functions, not only the Purchasing function, they are aimed at monitoring the source and not only its selection. Finally, present vendor rating systems are transparent to the suppliers and not only to the purchasers (table 1). Above all the present vendor rating systems use a wider range of criteria. On the basis of the literature review on vendor selection criteria carried out by Weber et al. [15], the "traditional" criteria are Quality, Delivery and Price. Urged by the need to consider current purchasing environments, which include Just-In-Time supplies and partnership agreements, present vendor rating systems give greater attention to other performance dimensions or organize the traditional criteria in a more detailed way. Performance dimensions found in the current literature regard, for example, the total cost of supply [16,17], Just-In-Time delivery capabilities [18], the cooperation in partnership agreements [19]. Recently, Lamming et al. [20] focused attention on the "relationship assessment", that is, the assessment of the overall partnership dimensions, underlying the necessity for a joint customer-supplier evaluation approach.

However, in spite of the fact that the collaborative product development approach is one of the most important aspects of present supply relationships, few works can be found in the literature that propose a structured measurement instrument. The "technical capability" of sources was already numbered among the vendor selection criteria in the seminal work of Dickson [21] in a secondary role in respect to the basic criteria pointed out above. However in Dickson's work, as in a series of other works (cf. [22,23,24]), it was not developed in detail. Some authors later tried to define the technological and R&D capabilities of sources in more detail, but without proposing an analytical measure. Mandal and Deshmukh [25], for example, affirm that the technical capability "refers to the availability of technical manpower, state of production technology, R&D facilities". Bhote [26] suggests measuring the technological and design profile of the supplier using the level of investment in R&D, the presence of Computer Aided Design/Engineering/Manufacturing Systems, the level of collaboration in the determination of product specifications and time reduction in product development. Cole [27] underlines the need for the buyer to measure the supplier's capabilities for "product design and testing, R&D, prototyping, manufacturing engineering and the overall technology and innovativeness". Ellram [28] suggests considering also the technological level of current and future manufacturing facilities and the supplier's speed in development. So, in general, the literature on vendor rating inserts the design skills of the suppliers within the generic "supplier technical capability" criteria, however a detailed measurement framework has not been adequately investigated as of yet.

The assessment of the supplier co-design capabilities: a methodology

The proposed measurement instrument of supplier co-design capabilities is divided in three components:

- The supplier's technological level, intended as the level of vanguard of the technologies used by the supplier;
- The supplier's innovation capacity, intended as the supplier's capability to innovate his products and processes;
- The supplier's co-design effort, intended as the quality of the contribution actually made by the supplier to the buyer during the NPD activities, that is, in the activities of product concept and functional design, product structural design, product and process engineering;

These three components are correlated. In general, in fact, the quality of the co-design effort produced by the supplier depends on his innovation capacity, which is in turn linked to his technological level. These two latter areas characterize his profile and determine his technological output. However it may occur that the co-design effort of a supplier is of inferior quality despite a high technological level and an elevated capacity for innovation. There can be many reasons, for example, as to why the buyer is considered of marginal importance, the required work has expanded into technological areas different from those usually occupied, problems of organizational co-ordination between the two firms have impeded a stable and effective collaboration. Thus, we believe that the evaluation of the first two components (technological level and innovation capacity) should be carried out separately when measuring the supplier's overall co-design capabilities. Precisely these first two components are those which are most thoroughly studied in the literature, especially the one belonging to the "technology assessment" and "innovation management" fields. This work, therefore, develops the third component in particular and the next section is dedicated to that. In the lines that follow only a few concise indications are given on the way of measuring the supplier's technological level and innovation capacity.

The supplier's technological level. Evaluation of the technological level generally does not regard the entire range of technologies used by the supplier, but is limited to those involved in the production and services he renders the buyer.

The indicators proposed in the literature are mostly perceptive and consist in the identification of the technology position of the supplier. Various classification systems of the technological position held by firms are proposed in the literature. They range from the defensive imitator - aggressive innovator [29] to the technological pioneer-late entrant typology [30]. In our approach, the essential dimension which needs to be considered is the rational balance between:

- Basic technologies: those technologies indispensable for product manufacturing but without particular strategic importance, as they do not offer competitive advantages;
- Emerging technologies: technologies in a state of development which are expected to change the bases of the competitiveness;
- Key technologies: these are the technologies that are crucial for the supplier, enabling him to compete with success in his sector. They constitute a distinctive capability of the supplier.

The basic technologies enable the supplier to operate in his market and so are indispensable for the more traditional types of work, those with low added value and which do not require sophisticated tools. However, if the supplier possesses only merely basic technologies, he cannot differentiate his offer and so becomes vulnerable to technical obsolescence. Thus it is important for the supplier to maintain a position also in key technologies (from which the suppliers gains the potential for differentiation from competitors) and in emerging technologies, in order to follow the technological frontier in the most promising fields.

The supplier's innovation capacity. The evaluation of the supplier's capacity for innovation, intended as the capacity to innovate products or processes (and in the final analysis his offer) is generally based on his effort in Research and Development (R&D) activities. The literature proposes a series of qualitative indicators that can be grouped into the following categories:

- R&D input indicators (i.e. the level of R&D expenses [eventually weighed on the turnover], the number of R&D professionals) [31,32];
- R&D output indicators, related to the technological effects (i.e. the number of registered patents, the number and scope of the technological fields covered by patents), the industrial effects (i.e. the contribution of new products to sales, the value of the technological balance [revenues by selling patents, licenses and know-how], the value of contract research), and the scientific effects (i.e. number of published articles and citations) of R&D activities [33,34];

- R&D efficiency indicators (i.e. number of patents per researcher/technician, the unit cost of the patents, % of the R&D projects with a positive commercial effect), [26,27,33].

The limits of these indicators, as is well known, are numerous. For example, the use of patents to measure the R&D activities poses a series of problems: the patent requisites differ from country to country, the "Quality" of the patents is, in general, extremely variable, the propensity to patent varies according to the sector or to the firm, often the patenting cover is avoided for security reasons. In addition, it is the value and the capacity of the researchers, more than their number, that determines the innovation output of a firm. Besides, much of this information is not readily available to the customer. In any case, an evaluation, even if approximate, of the suppliers innovation capacity seems to us indispensable for a more complete estimation of his co-design capabilities.

The supplier co-design effort

The supplier co-design effort, regarding product and process technologies, is for the most part intangible and so difficult to quantify. However, a perceptive estimation, if sustained by an adequate framework is, in our opinion, necessary to appraise the contribution offered by the sources, compare the suppliers, and monitor their improvement over time. The indicators, of a perceptive nature, which we chose to measure the supplier co-design effort are shown in table 2. They are evaluated by the design team downstream from the NPD activity. One of the following questions, grouped according to the principal phases of product development, corresponds to each of the proposed indicators.

The measurement of the suppliers's co-design effort*

	min↔max	Weight	Score
Product concept and functional design			
(a) Technological expertise	1 2 3 4 5	—	—
(b) New technologies identification	1 2 3 4 5	—	—
(c) Support in the development of product specificat.	1 2 3 4 5	—	—
(d) Support in value analysis/engineering activity	1 2 3 4 5	—	—
Product structural design and engineering			
(e) Support in product simplification	1 2 3 4 5	—	—
(f) Support in modularization activities	1 2 3 4 5	—	—
(g) Support in component selection	1 2 3 4 5	—	—
(h) Support in standardisation choices	1 2 3 4 5	—	—
(i) Efforts to make product and process compatible	1 2 3 4 5	—	—
(l) Promptness and reliability in prototyping	1 2 3 4 5	—	—
(m) Prompt communications of engineering changes	1 2 3 4 5	—	—
(n) Support in FMEA activities	1 2 3 4 5	—	—
Process design and engineering			
(o) Support in DFM/DFA activities	1 2 3 4 5	—	—
(p) Support in process engineering equipment	1 2 3 4 5	—	—
			Total

*Legend: 1. The supplier's support has been negligible. 2. The supplier's support has been limited and irregular. 3. The supplier's support has been sufficient. 4. The supplier's support has been important. 5. The supplier's support has been decisive.

Table 2. The measurement of the supplier's co-design effort

Product concept and functional design

- a) *Has the supplier been transparent regarding his technological expertise?*
- b) *Has the supplier contributed to the identification of new materials and new product and process technologies?*

The concept of a new product should take into account the materials and technologies available, either at the buying firm or the suppliers collaborating in the project or, more generally, the technological supplies market. A knowledge of the technologies available to the supplier thus can influence the choice of the designers and the product managers in the development of a new product [46]. The competitive need to shorten the time to market and to incorporate into the product an ever wider range of technologies forces the buying firm to make an accurate check of the technological markets: innovations are spotted and acquired wherever they are available. From this point of view the suppliers assume the role of direct source of innovation or “gatekeepers” oriented towards the sources of innovation in their own or related sectors. Using the suppliers as “gatekeepers”, the buyer firm has a greater possibility of coming into contact with innovative ideas and to choose the most promising ones [46,48].

- c) *Has the supplier provided useful information for making decisions regarding the choice of product components?*

The main choice regarding component production (Use of new or existing parts? Internal or external development? Which technologies to adopt for the basic components?) greatly condition the competitiveness of the product. The use of existing parts (common to other models or taken from former models) reduces the cost of designing and manufacturing new equipment and the risks of unreliability. However this solution is not always practicable.

Similarly, the involvement of external resources can improve the quality of the components and reduce the internal work of planning and co-ordination, but it could also result in a deterioration of the internal know-how. Besides, the neglect of component basic technologies could weaken the negotiating position of the customer in regard to the supplier [6]. Thus recourse to external sources for product development must be carefully calculated. When making this choice the designers must take into account not only the technological characteristics of the components to be developed but also the suppliers profile and potential. Therefore, an element to be evaluated is their willingness and timeliness in providing information of this type [41].

Product structural design and engineering

- d) *Is the supplier timely and reliable in making the prototypes?*

The speed and the quality of constructing prototypes have a significant influence on the speed and quality of the entire activity of NPD. The prompt availability of externally made component prototypes provides the designers with a more rapid feedback, quicker execution times, a precocious diagnosis of the problems, cutting down on the time needed to plan alternatives for a more rapid modification of tools and dies. In addition this permits, within the same amount of time, a greater number of prototypes to be made: the speed of external prototype realization increases the frequency of the cycle design - prototype - test, which is carried out repeatedly until the final result is obtained [4].

e) Has the supplier promptly provided information relating to any modifications carried out during the prototyping stages?

Engineering changes made by the supplier during the prototyping stages can occur frequently. The cost of engineering changes made after the design stage tend to increase exponentially along the NPD process. The promptness with which these are communicated to the buyer's NPD team helps the work of re-designing and speeds up the testing operation. The savings in cost and time are notable, especially when the changes to be made in the project are not subject to formal approval (as often happens) before being passed on to the prototype workshop [4].

f) Has the supplier used advanced technological know-how to make the prototypes?

The quality and the speed of the prototyping process depend also on the instruments used by the supplier. Instruments which are technologically advanced such as solid modeling, dynamic simulation, Computer Aided Engineering, besides speeding up the whole development process, enable possible problems and defects to be identified more quickly, and so successive phases of product analysis and testing are carried out more easily [6].

g) Has the supplier tried to make the designing of the product compatible with his own processes?

The attempt on the part of the supplier to make the characteristics of the product and the characteristics and potentials of his own productive processes compatible can lead to shorter lead times and cost containment [21]. The benefits for the buyer are an advanced availability of the components and possibly also a reduction in the cost of acquiring the supplier's components [12].

h) Has the supplier made a significant contribution to the product specifications?

The product specifications are the translation of functional requirements that the designer seeks to incorporate in a product. These specifications, in turn, are the basis for procurement and process planning activities [12]. In what way can the supplier help the buyer firm designer to define the product specifications? First of all to identify analytically the importance and the technological impact of each specification, estimating the cost linked to it and helping to modify those which contribute to additional costs. Moreover, the supplier's contribution can be important also for the formulation of the specifications so that these:

- are expressed clearly and comprehensively;
- are sufficiently precise and rigorous;
- provide enough information for inspection and quality test purposes;
- do not include unnecessary and nonessential features.

The determination of specifications with these characteristics is then reflected on the attractiveness of the product and its competitiveness on the market [20].

i) Has the supplier significantly contributed to the activity of VA/VE?

Value Analysis and Engineering provides a systematic approach to evaluating which design and manufacturing alternatives are essential to achieving product specifications. In assessing the value of an alternative, both functional value and esteem value are considered. Functional value is the perceived

value of the intended use. Esteem value refers to the aesthetic features of the product which are appreciated by the customer. To achieve maximum functional or esteem value is to achieve the lowest possible cost of providing the performance function or the aesthetic features [43].

In reference to all the primary and secondary purposes VA measures the degree of usefulness and the appreciation of the product by customers. Starting with the hypothesis that the user is willing to pay only a limited amount for some supplementary functions of the product which he is buying, the aim of VA is to manufacture a product at the lowest cost, but with the highest degree of all the functions appreciated by the customer and without those function whose utility is not perceived. The cost evaluation is made by Value Engineering (VE) which, function by function and component by component, considers the materials to be used and the work to be done. Especially in the quantification of the costs associated with each performance of the product, the contribution of the suppliers can become determinant so that the VA and VE activities can be completely fulfilled [49].

l) Has the supplier contributed significantly to product modularization?

Modularization permits differentiated products to be obtained in unison with economy in the design activity, production and management of logistic flows, thanks to a repetitive use of standard elements in the definition of the product [10,12]. The suppliers contribution can be valuable where the product modular composition requires modifications in the designing of the single components.

m) Has the supplier made a significant contribution to FMEA?

Failure Mode Effect Analysis (FMEA) techniques provide the design team with a systematic approach to study what the causes and effects of product failures. FMEA specifies the various conditions of use the product will endure, and tests how it reacts under those conditions, allowing designers to shape the product to withstand a broader range of conditions. Designers can make better informed decisions regarding the use of materials and components depending upon their performance and cost. Suppliers can use their detailed knowledge of the component to suggest lower cost solutions to problems revealed under various conditions of use.

*n) Has the supplier made a significant contribution to the design/use of standard components?
Has the supplier resorted to standard components?*

The use of standard components means that parts will be more quickly available along with a wider choice of sources, thereby determining a reduction in the production lead time and of both product and inventory costs. The designing of standard components can be aided by Automated Design Systems (for example Computer Aided Design) which include archives of elements made available by suppliers and which are automatically included in the design [10]. By so doing the supplier can suggest standardized solutions to the customer firm designers, avoiding that frequent occurrence *Òreinventing the wheelÓ* which he is forced to do when the buyer designer, especially if idiosyncratically preferring pre-established technical solutions, neglects his offer [4]. Similarly, the use of standard components by the supplier can enable him to speed up and make his offer more economical.

o) Has the supplier contributed significantly towards simplifying product design?

The current competitive need towards a faster introduction of new products or new versions renders critical the ability to effectively and efficiently manage the design and productive complexity, especially when the number of product components is high. From this springs the necessity to simplify, to the

maximum, the structure of the product and the process, limiting the number of components and production or assembly operations. Simplifying product design results in numerous benefits such as reduced costs, improved quality, and shorter development lead times. Also in this direction the contribution of the supplier could be valuable.

Process design and engineering

p) Has the supplier contributed to the application of DFM/DFA techniques? Has the supplier resorted to these techniques in his own factory?

Design For Manufacture (DFM) takes into consideration the effects of product structure on manufacturing costs and “producibility”. Benefiting from a collaborative approach between the design and production functions, DFM aims at the simplification of the productive processes, characteristics and performances of the product being equal [48,36].

Similarly, the Design For Assembly (DFA) is proposed as a means of containing costs while maintaining the high quality of the assembly activities by means of an appropriate choice of assembly methods, reduction in movements and directions of assembly, the installation and link of the components associated with form, materials, technology etc. [6]. The use on the part of the supplier of these techniques of integrated product/process design permits the buyer to receive the supplies in a shorter time, as well as (possibly) at a more competitive price. The supplier’s experience and suggestions could, in addition, be useful in the buyers DFM/DFA activities.

q) What was the suppliers level of involvement in the executive designing of tools and machinery used in the productive process?

The pilot tests, which usually conclude the activity of process engineering, are the moment when the designing problems accumulated during the preceding phases become evident. Their principal scope, in fact, is that of discovering and solving the problems that had not emerged during building and testing phases of the prototype. Also here the supplier’s contribution and experience could turn out to be valuable [38].

The evaluation of synthesis

The framework presented in the preceding section pinpoints a series of indicators for the evaluation of the supplier co-design capabilities. At this point, the weight to be attributed to each indicator depends on a series of variables:

- the stage at which the supplier is involved in the NPD activity. Clearly, evaluation of the supplier can concern solely those stages in which he took part. Besides, the earlier (near to product concept) the supplier gets involved, in other words the greater his knowledge is of the entire project and the needs of the customer, the richer and more punctual his contribution will be to the co-design activity;
- the nature and importance of the component supplied The technological content, the possibility of standardizing and simplifying the product/process, the complexity of the prototyping activity, the impact on the functional characteristics of the finished product vary according to the component supplied;

- capabilities within the customer firm. In general, the supplier capabilities that are most appreciated are those “complementary” with respect to the buyer because they allow a more complete NPD work;
- competitive priorities of the buyer firm. For example, the need to shorten the time to market renders the speed at which the prototype is constructed and the processes set up critical, while the need to reduce the costs emphasizes the supplier’s contribution in the activity of standardization or simplification of the product/process.

An example of application

In this section we give an example of how the proposed instrument can be applied, an example limited to the evaluation of the supplier's co-design effort, carried out in an important firm which operates in the sector of Industrial Automation, and is situated in the north-west of Italy. The firm is part of a multinational group and makes machinery and plants for the companies of the group (food sector). The turnover amounts to about 20 millions USD: the purchases account for about 70%. The firm is make-to-order, typically offering single products or small lots. Each customer order is assigned to a project-leader who manages the development activities from the preliminary analysis until the product is ready for use. The project-leader coordinates a cross-functional team involving: purchasers, technical specialists (in automation, electronic equipment, etc.), and suppliers’ guest engineers. Collaboration with the suppliers has become a critical factor for success since they determine the manufacturer's product quality, innovation and Time To Market (TTM). For this reason the firm wished to have an instrument for the assessment and monitoring of supplier's codesign contribution. In conformity with the proposed instrument, the indicators used are organized according to the main NPD phases.

Product concept and functional design

The level of technological expertise and the transparency (a) of the supplier are considered parameters of prime importance. In fact the firm seeks out suppliers that are leaders in their field and relies on them for the identification of new technological opportunities on the supply market. The innovation of materials (b) is particularly appreciated, above all those which are able to reduce costs. In fact the materials account for about 70% of the entire cost of the finished product. Similarly, new process technologies (b) able to offer a quicker flow progress and a greater control of its characteristics are factors that are in great demand. New technologies that have been incorporated into the product thanks also to co-design efforts with the suppliers regard the multi-axis approach, the use of composite materials, of optical fibers and of new software protocols. An important research work on the hardware and software compatibility between components and products (for example Programmable Control Machines) made by different producers (Siemens, Hallen Bradely, etc.) was then carried out by some suppliers together with the firm’s informatics experts. Generally the prospective of a mutually advantageous long term relationship favors frankness concerning new materials and technologies.

The support of the supplier in the choice of components (c) is carefully evaluated. This choice directly influences the TTM, which is one of the competitive priorities of the firm. Thus components that are readily available on the market and have a low delivery lead time are favored. The firm expects that the indications regarding the availability on the market of parts with these characteristics (or regarding already known parts but of which they are unaware of other possibility applications) come from the

supplier. The latter, within the limits of the part they supply and the complementary components, have a greater depth of knowledge of the supply market. Thanks to the active involvement of the suppliers in this area the firm has reduced the TTM relative to some machinery to one month and the TTM of installation to 4-6 months.

Product structural design and engineering

Almost all the products made by the firm pass through the prototype phase, needed to verify the actual working of the product, check whether the specifications were respected and identify with precision the phases and complexity of production. For example, the construction of a robot needs the principal building elements to be prototyped: the motion system, the control system software, the support component construction, the frame, the crankcase. The speed and reliability of prototyping (d) guaranteed by the suppliers has a direct effect on the quality of the product and the TTM. Similarly the firm expects the suppliers to quickly pass on all information relative to any modifications carried out during the prototyping phase (e). Modifications during this phase are in fact frequent, especially when there is a high content of innovation in the product thus requiring numerous and follow-up testing.

The supplier's search for compatibility between the product and the internal processes (g) is another of the parameters analyzed at this stage. This parameter is important for two reasons: (1) with product-process compatibility the manufacturing lead times are reduced and thus the whole TTM; (2) product-process compatibility is a prerequisite for respecting the design specifications. Such compatibility is required both in relation to materials and single processes, including the most simple ones (for example: surface finishing).

The firm carefully analyzes the tests for defects carried out by the suppliers: in the past the finished product had often shown problems regarding resistance to wear precisely because some components had not been sufficiently tested. Similar problems have been found, for example, with parts most liable to stress, such as jaws and sliding elements. It has also occurred that insufficiently tested components have generated dust, a very serious factor in the market where this machinery is used. The support in the FMEA activity (m) is thus an integral part of the supplier measurement system.

Some development projects managed by the firm require thousands of components, though their number varies considerably from order to order. The importance of a reduction in the number of components (o) and recourse to standard components (n) is then evident. Such components are more easily found, cost less and are available in shorter times. For example, the firm has considerably reduced the number of components associated with the pneumatic part of the product thanks to suggestions made by some suppliers.

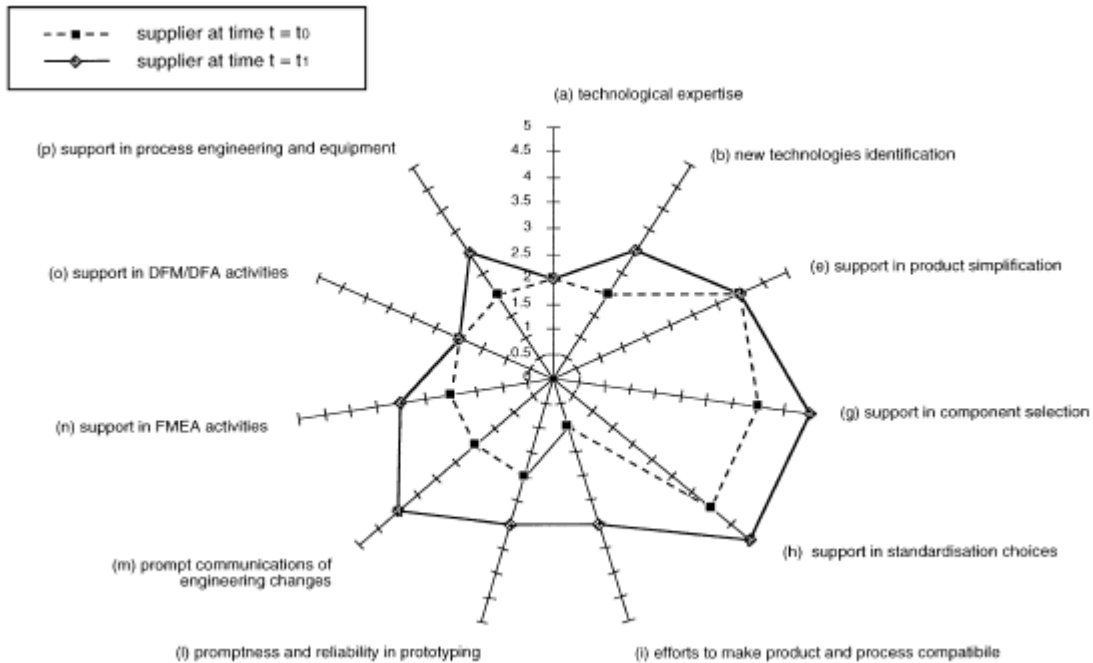


Figure 1. Example of monitoring at $t = t_0$ and $t = t_1$ a supplier involved in NPD

Process design and engineering

Particular importance is given to the supplier's support in the simplification of the assembly, maintenance and disassembly of the products (p). Products can be more quickly and easily built and maintained with this kind of help. In particular, great importance is given to ease of maintenance, so that the buyer firm can use internal personnel instead of outside specialists. In addition the market demands stringent norms of cleanliness in the process. So the machinery must be easily disassembled to allow frequent cleaning. Finally, this type of machinery is subject to a high amount of wear and components must be changed frequently.

Note that some of the indicators described in the preceding section were not considered significant in the situation analyzed: the use of advanced technological know-how at the prototyping stage (f), the support of the supplier in the development of the product specifications (h), the support of the supplier in VA and VE activities (i); the support of the supplier in product modularization activities (l). Therefore, they were not included into the evaluation model.

The evaluation of the suppliers according to the parameters listed above is the responsibility of the project-leader, who makes a draft in collaboration with the specialist designers once the constructive phase of the project has been completed. The results are communicated to the Purchasing and to the Quality manager, beyond the evaluated supplier. Figure 1 gives a graphic example of the application of the proposed instrument.

Summary

In the context characterized by increasingly aggressive global competition, higher costs for research and development of new products, technologies in rapid evolution, the need to speed up product development in order to reduce the "time to market", competitive success depends more and more on product development. Many firms have thus felt the need to review the traditional antagonistic procurement logic, involving the suppliers right from the first stages of product development. The mode of managing the pool of suppliers, in particular the vendor rating systems, have thus assumed a new and central relevance [35].

The objective of this work was to develop a tool for the measurement of the support given by the suppliers in NPD activities. In spite of its increasing spread, co-designing is often neglected in the abundant literature on vendor rating. The instrument consists of a structured grid for the detailed analysis of the capacity and quality offered by the suppliers in the development stages. The instrument was tested in an important firm working in the Industrial Automation sector. Its application showed the importance of an analytical evaluation of the suppliers in firms for which the correct management of the external sources, especially those involved in product development, constitutes a critical factor for success.

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