Selecting Quality Based Programs in Small Firms

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ABSTRACT. Over the last decades, the quality issues have received increased attention from top managers and academics. The international debate mainly focused on managerial and economical implications resulting from the implementation of TQM programs in large companies, thus not considering peculiarities that such investments present within small firms. As a matter of fact, many small firms have adopted quality based programs and, unfortunately, failed to achieve the planned results: a major reason of the failure of TQM initiatives is due to the lack of effective decisional tools aimed at identifying the most suitable quality related investments.

Hence, the objective of the paper is to define a model that supports managers of small firms in the identification of most effective quality related priorities: to this end, a contingent approach that identifies different contexts according to the environment where the company operates and to the relationships between the firm and its stakeholders is suggested. Guide-lines for choosing a specific decisional technique aimed at selecting the most effective choice among the identified feasible priorities are suggested, too.

1. Implementing TQM programs in small firms

Over the last decades, economic literature and most corporate executives indicated quality as one of the main sources for cost reduction and for improving the company's competitive position (Carbonelli *et al.*, 1992; Hagan, 1986; Juran, 1988; Juran, 1993; Noci, 1995; Schaffer and Thomson, 1992). However, few researches have analysed how small firms have implemented quality based initiatives and main economical/managerial problems arising from the adoption of TQM programs within such companies.

The analysis of the effects resulting from the adoption of these initiatives within small firms is extremely important because of peculiar characteristics of their quality systems. Indeed, we have to consider that small firms have some advantages and some points of weakness with respect to large corporations. In particular, the company's size, the presence of an entrepreneur with a positive style of leadership, flexibility of operating procedures for managing employees represent points of strength that favour the small firm in the successful implementation of TQM programs. On the other hand, some barriers – that are common to all companies introducing innovative techniques or new organizational procedures – become more important in small firms: we refer to the lack of financial resources, the lack of information, the deficiency of middle management that is able to support the improvement of product and process quality. More precisely,

i) the lack of financial resources limit the feasible initiatives that a small firm can implement;
ii) the limited managers' competencies contribute to make unclear the concept of total quality management; on the one hand, small firms tend to be "technique reactive" as they often confuse the implementation of a particular technique with TQM; on the other hand, their main focus is on operations and, hence, they implement quality based programs in few activities/organizational units of the corporate quality system;
iii) information systems based on a limited set of data could hinder the effective assessment of quality based programs that – like many empirical studies suggest (Azzone and Noci, 1994; Noci, 1995) – often requires the collection of both tangible and intangible performance;
iv) the lack of middle managers and of a well established organizational structure could make ineffective the implementation of the

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selected TQM initiatives, since the effective management of quality issues does not only depend on the company's operating procedures but on flows of communication that middle managers are able to establish (Ciambelli and Lo Storto, 1994; Garvin, 1988).

In spite of these differential characteristics, managers of small firms have implemented quality based programs merely borrowing approaches adopted by large corporations. As a matter of fact, a great number of researches and case studies suggest that many of the implemented quality based programs failed (Dale and Lightburn, 1992; Juran, 1993); in particular, in a 1992 survey developed within small companies that supply great international corporations as FIAT and IBM, it emerged that small firms did not achieve both economical objectives related to the reduction of the company's quality costs and efficiency based aims associated to the improvement of i) the company's operating procedures and ii) quality defects by even a little percentage as 10% of the scraps produced during 1990 and 1991 (Carbonelli and Noci, 1992).

In our opinion, the failure of quality based programs carried out by small firms not only depends on the implementation of programs that were only suitable to large companies but it is mainly due to the lack of effective decisional tools. Hence, the adoption of investments that are borrowed from experiences of large companies is often the consequence of the introduction of models that did not point out the negative effects following from the implementation of such investments within small firms.

In particular, by considering the process of evaluating quality based programs as the result of two steps – i) the selection of feasible quality related priorities and ii) the identification of the most effective alternative – we point out that no state of the art model is effective in supporting the former step of the analysis. On the other hand, specific and effective models exist as regards the second step of the analysis – i.e. the evaluation of most effective investment among a few identified options – (Bromwich and Bhimani, 1991; Buss, 1983; Campanella and Corcoran, 1983; Canada, 1986; Eldridge and Dale, 1989; Godfrey and Pasewark, 1988; Heagy, 1991; Kaplan and Norton, 1992; Morse, 1983; Morse and Poston, 1986; Nelson, 1986; O'Neill, 1988; Plunkett and Dale, 1988; Porter and Rayner, 1992; Son and Hsu, 1991). Unfortunately, their implementation needs a lot of data and a time consuming analysis and this implies some problems since small firms do not often have an effective information system for measuring quality related performance and a staff aimed at investment appraisal; for this reason, they can be adopted only when managers have identified few feasible quality related programs representing the main priorities with respect to the current quality performance.

According to these issues, in the following, we suggest a conceptual framework aimed at i) identifying potential quality based programs and ii) defining under which conditions each of them could represent a priority and, hence, should be evaluated in more detail.

The paper is articulated into 3 major sections.

Section 2 analyses main limits of state of the art decisional tools when they are implemented for selecting quality based priorities. Section 3 describes the suggested framework for identifying the most suitable quality related priorities in different decisional contexts. Section 4 compares techniques for the identification of the most effective quality related investment among the identified priorities.

2. The adoption of state of the art approaches for selecting quality based priorities

State of the art literature does not suggest any specific model for selecting quality based priorities in small firms. However, among the approaches that have been designed for supporting decision making on quality issues, we can identify three groups of models that can be used to achieve this objective, too; these are:

- models based on physical indicators (Noci, 1993; Noci, 1995);
- Quality Costs based approaches (Aubrey, 1988; Campanella and Corcoran, 1983; Eldridge and Dale, 1989; Heagy, 1991; Morse, 1983; Morse and Poston, 1986; O'Neill, 1988; Plunkett and Dale, 1988; Porter and Rayner, 1992; Son and Hsu, 1991); and
- scoring methods (Noci, 1995; Nelson, 1986).

2.1. *Physical indicators*

A system of non financial indicators aimed at monitoring the company's quality related performance is based on the collection of information about the level of scraps, re-manufactured products and, more generally, of all deviations from design specifications.

Most common indexes used in practice for measuring quality related performance can be synthesized as follows:

i) output measures aimed at assessing the effects of each quality based investment on the production system: within this category, we have, for instance, the percentage of defective identified products, the percentage of products to re-manufacture, the number of defective identified products vs. number of defective products outcoming from the firm's plants, the number of delays due to wrong process instructions, etc.;
ii) output measures that analyse the effects of each quality based investment on the information system, as, for instance, the percentage of reports delivered on schedule, the number of revisions to plan, the percentage of customers' problems not corrected per schedule, the number of errors found after formal testing, the percent error in lines of code required, etc.;
iii) measures pointing out the effects of the investment on design and engineering activities, as, for instance, the percentage of errors found in the design review, number of problems that were also encountered in previous products, cycle time to correct a customer's problem, etc.

According to these measures, quality related priorities can be selected in two different ways:

1) by identifying the investments that determine the greatest improvement of physical indicators. For instance, the priority of investments in new equipment can be identified in relation to their impact on the percentage of defective products outcoming from the production department;
2) by the screening of different quality related performance to identify where a firm achieves the worst results and, hence, the function and/or the company's department in which quality related investments appear more compelling.

Physical indicators based models do not represent an effective tool for selecting most promising quality related alternatives. In fact, by the former type of analysis, we only identify most suitable programs among investments that affect the same set of physical parameters, but we are often unable to compare investments adopted in different corporate departments; the latter analysis points out the worst quality related performance but it does not enlighten the causes of the negative result: hence, in this case, we can identify the company's activities/processes that need new investments but we are often unable to define the initiatives that allow the company to improve its quality performance.

2.2. *Quality costs*

Quality Costs synthesize different cost items associated to the level of quality of conformance achieved by the company. They can be divided into four categories:

- prevention: costs related to training employees, investment in new equipment and aimed at redesigning products and processes to reduce the number of defective products realized within the company's plants;
- appraisal: costs of product inspection to ensure that products are consistent with design specifications;
- internal failure: costs related to products detected as defective within the company's boundaries (i.e. costs for re-manufacturing defective products or costs related to the achievement of wastes, etc.); and
- external failure: costs associated to products that, once sold into the market, have been defective identified by customers (i.e costs for managing customers' complaints, opportunity costs of lost sales, costs for re-working defective products, etc.).

Many authors (Campanella and Corcoran, 1983; Eldridge and Dale, 1989; Godfrey and Pasewark, 1988; Heagy, 1991; Morse, 1983; O'Neill, 1988; Plunkett and Dale, 1988; Porter and Rayner, 1992)

suggest that Pareto analyses on Quality Costs should be developed for identifying quality related priorities. We believe that Quality Costs based models have some problems to achieve this objective; in fact, different categories of quality costs have complex relationships that are not identified by the model. The extent of external failure costs, for instance, depends on the amount of internal failure costs since the reduction of external failure costs could follow from the improved efficiency of the on-line inspection and testing activity, and, hence, it could be associated to growing internal failure costs; but, we cannot identify that the adoption of investments in inspection and testing represents a primary need simply in relation to the rise of external failure costs: this could, in fact, follow from:

i) a rise of the production volume – in this case no quality related problem emerges – or, from
ii) the increased obsolescence of production equipment, thus pointing out the need of adopting investments that could not be identified by the Quality Costs based model.

Moreover, Quality Costs based approaches do not define relationships between prevention and internal, external and appraisal; hence, by model implementation we are not able to identify which expenditures in prevention represent a promising alternative with respect to the set of potential investments.

2.3. *Scoring methods*

The implementation of scoring methods for identifying quality related priorities can be articulated into three steps:

a) the definition of i) the set of objectives – related, for instance, to the reduction of the percentage of defective products and of the number of claims for delivered defective product –, and ii) of their relative importance by a numerical weighted score;
b) the identification of the expected contribution to each objective by means of a score on a numerical scale; and
c) the calculation of the total score by identifying the weighted average of the scores corresponding to each objective.

Hence, quality related priorities correspond to alternatives with a score that exceeds a planned target.

According to the above issues, it emerges that quality related programs are identified by a multi objective analysis aimed at defining the consistency of each investment with the firm's goals; nevertheless, its implementation is critical because it does not suggest how we can identify the relative importance of different objectives: for this reason, it is highly subjective as regards the definition of weights.

The above analysis has pointed out some general limits of state of the art models that are relevant apart from the company's size. However, to better comprehend how these models perform within small firms, we have also to consider that no state of the art decisional tool allows managers i) to develop a timely analysis and ii) to define clear and precise programs. These low performances of traditional models with respect to most important requirements for approaches aimed at selecting quality based priorities in small firms have a great importance; in fact, such companies need i) to timely react to external or internal pressures to achieve a competitive advantage by exploiting their flexibility and ii) to refer to clear objectives to avoid dissipation of financial resources.

3. A contingency model

To identify feasible quality related priorities within small firms, we suggest a model that is based on the wide, even if fragmented, literature that deals with quality related issues. In particular, the designed approach analyses how the characteristics of the small firms' quality system and main peculiarities of their competitive environment affect the effectiveness of different quality based programs.

The model is articulated into 4 phases (Figure 1):

1) the definition of main types of investments that can improve the company's quality performance;
2) the identification of variables describing the small firms' competitive environment and their effects in the process of selecting most suitable quality related priorities;

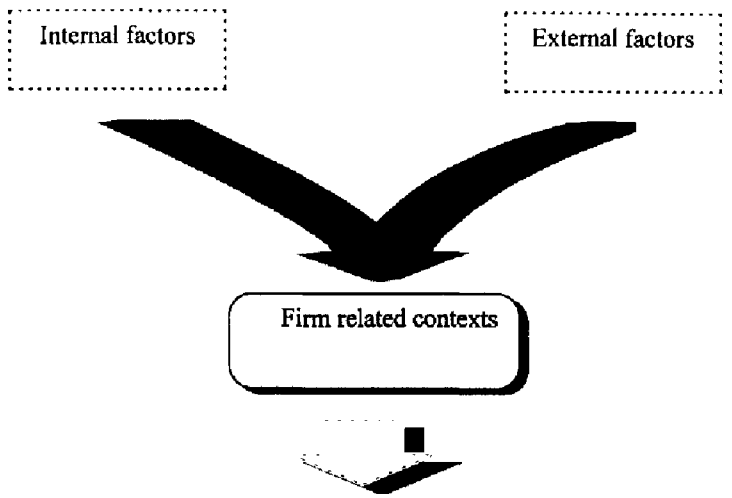

Fig. 1. The model structure.

3) the analysis of variables describing the small firm's internal configuration and of their effects in the selection of most effective quality related priorities; and, finally
4) the definition of the global framework – comprehending variables related to both the external environment and the firm's internal configuration – in order to identify in which contexts the identified investments represent a priority and, hence, should be analysed through approaches of investment appraisal.

3.1. *A taxonomy of quality based investments*

To identify a set of investments that express all feasible solutions a company can implement to improve its quality related performance and, at the same time, present different managerial implications as regards their implementation, we point out that within small firms:

i) quality based initiatives are often considered according to a technical viewpoint: TQM is often seen as a set of techniques that only affect the departments/activities in which they are implemented; because of this limited perspective, the adoption of programs that affect the whole corporate system must be carefully considered since the investment effectiveness could be low;
ii) the lack of financial resources limits the introduction of capital intensive innovative solutions; for this reason, it's important to distinguish between quality based initiatives related to the modification of the company's technological resources (*hard investments*) and programs mainly aimed at modifying the company's organizational procedures (*soft investments*).

According to these issues, we identify a taxonomy of quality programs that is based on two variables:

- the type of the problem under evaluation; and
- the financial cash outlay needed for the implementation of each investment.

The former axis reflects the area of the corporate quality system affected by the investment and, for this reason, makes it easier the identification of the specific performance influenced by each alternative. We distinguish, at a first level, between *local investments* and *systemic investments*: the former are aimed at improving the performance of a specific activity or organizational unit of the quality system, while the latter affect the whole corporate quality system.

At a second level, we have (Azzone *et al.*, 1994; Noci, 1995),

- in the area of local programs:
  - supplies,
  - identification of customers' needs,

  - design,
  - training,
  - manufacturing, and
  - inspection;
- in the area of systemic investments:
  - investments in product certification, and
  - investments in quality system certification.

The classification based on the cash outlay points out the financial risk of each investment: in fact, capital intensive programs are likely to be evaluated on the basis of more analytical approaches than programs requiring a limited cash outlay.

3.2. *The impact of the environment*

The identification of main characteristics of the small firms' competitive environment makes it easier the selection of feasible quality related priorities, since the effects resulting from the implementation of different investments depends not only on the firm's internal configuration but on relationships between the company and its stakeholders. This is the case, for instance, of investments aimed at improving the efficiency of the inbound inspection and testing unit: their implementation is effective in contexts where the firm has a limited bargaining power with respect to its suppliers; in the other cases, the adoption of co-operative relations aimed at improving the quality of the supplied components at the source (i.e. within the supplier's quality system) represents a more efficient solution.

To define how the competitive environment leads managers to select different quality related priorities, we refer to three environmental factors: the binding force of regulations, the bargaining power of suppliers and customers. The first variable is important apart from the company's size since quality related investments could be compulsory for all firms in order to conform their product quality performance with standards set by regulations. Variables related to the firm's bargaining power with respect to external stakeholders have been introduced to support decision making within small firms; in fact, the relative concentration between firms involved in the economical transaction and the relative availability of financial resources (Porter, 1985) play an important role in determining the company's bargaining power and they are often at the disadvantage of the small firm: hence, to identify main quality related priorities, we have to carefully take into account the relationships between the company and its stakeholders.

According to the above issues, we characterize the environmental contexts according to two classes of variables:

- external pressures resulting from *customers' bargaining power* and the *binding force of regulations* that compel the firm to adopt the required quality related programs; in particular, we distinguish between i) *compulsory environments* – i.e. contexts characterized by legally binding regulations or an high customers' bargaining power – and ii) *free environments* – i.e. contexts characterized by low customers' bargaining power or binding force of regulations;
- *firm's bargaining power vs. suppliers*: the introduction of this variable allows us to identify when a firm can i) unload to suppliers some relevant quality costs or ii) execute design and engineering of the product with suppliers.

Below, we discuss – through some propositions – the influence of variables describing the small firms' competitive environment on the effectiveness of each quality based investment.

Proposition 1: in compulsory environments, all the requested investments must be implemented.

This is, for instance, the case of investments in certification required for entering into foreign markets. In small firms these investments have some negative implications, as they stiffen the structure; nevertheless, the cost of lost sales resulting from the refusal of stakeholders' requirements exceeds the negative impact resulting from lower flexibility (Noci, 1995).

Proposition 2: in free environments and within small firms with sufficient financial resources, the adoption of i) pro-active strategies and ii) market and design related investments represents a priority.

The effectiveness of such investments is related to the growing importance of the correct identification of key product performance with respect to customers' requirements and of the product design specifications (Newall and Dale, 1991). In small firms, these issues are even more important:

in fact, many researches point out that the adoption of TQM initiatives does not follow from efficiency based objectives related to i) the optimization of the company's operating procedures or ii) to the reduction of the whole manufacturing costs, but from marketing purposes aimed at anticipating future customers' pressures (Lascelles and Dale, 1990).

However, to have a complete picture of the effects resulting from the implementation of different quality related investments in free environments, we must consider variables related to the *firm's bargaining power vs. suppliers* and its internal configuration.

Proposition 3: in small firms with high bargaining power vs. suppliers, the implementation of investments in quality of supplies (i.e. in the suppliers' quality systems) is effective (Saccani, 1990; Williams and Smith, 1990).

Such investments allow the company to:

- save a) costs associated to the purchase of defective raw materials and b) operative expenses regarding inbound inspection;
- reduce loss of time resulting from equipment stop and due to quality failure of raw materials and components.

Proposition 4: within small firms with i) high quality related competencies and ii) great bargaining power vs. suppliers, the adoption of design related investments aimed at improving the product engineering – according to specifications requested to suppliers as regards the quality of their components – is effective.

Due to the lack of managerial competencies within small companies, it is hard to implement complex quality based initiatives – as TQM programs – that require the involvement of external stakeholders, like, for instance, suppliers: the joint product development of the firm with its suppliers requires great managerial efforts for the definition of product specifications since there are two different organizational units, belonging to different companies and with different competencies, that have to communicate. Nevertheless, there are small firms with enough quality related competencies to effectively support systemic quality related programs jointly implemented with external stakeholders, too: this is the case, for instance, of Italian companies operating in the aeronautic field that, because of the standards set by regulations, have established mutual relationships with suppliers to conform their product performance with prescriptions of rule making boards.

In particular, to understand the motives that make effective design related investments in such companies, we have to consider that, by their implementation, the firm can:

i) reduce production lead time (Bartezzaghi *et al.*, 1994): in fact, by the brain-storming and the "co-design" with suppliers, the company can design components that avoid problems, as equipment stop, in the production cycle;
ii) improve the product quality and, hence, increase the company's market share.

Further investments in inbound inspection and testing are not suitable: in fact, the great bargaining power of the firm ensures the consistency of the supplier's product quality with the firm's requirements.

Proposition 5: in an environment characterized by the company's limited bargaining power vs. suppliers, the implementation of investments in inspection and testing greatly contributes to improve the firm's quality performance.

Within small firms, such investments limit the absorption of financial resources due to working defective raw materials and components and, at the same time, they improve the company's economical performance by reducing both:

- costs for work in progress/products to be rejected and re-worked (Heagy, 1991); and
- costs of lost sales or costs related to customers' complaints due to the delivery of defective products.

3.3. *The implications of the small firm's internal configuration*

To define the small firms' internal configuration, we introduce three variables: the market turbulence, the managers' competencies and the level of product quality performed by the firm with respect to its competitors. More precisely,

i) the *market turbulence* is one of the key variable that allows us to justify the effectiveness of different quality based investments

within small firms: in fact, the more the market is turbulent, the more the adoption of programs requiring great financial resources can be hardly justified;

ii) the identification of the managers' competencies allows us to define the firm's capability to adopt and use new technologies and to define effective operating procedures. As many researches suggest, the lack of skilled managers is one of the major reasons that explain the failure of the implemented quality based initiatives; in particular, the lack of suitable managers' competencies has two negative implications: it could lead managers i) to select quality related programs that are not consistent with the company's infrastructural resources or ii) to implement suitable quality based initiatives but according to a technical perspective. We do not consider the employees' skills, because the successful implementation of quality based programs primarily depends on how they are presented and introduced by managers (Williams and Smith, 1990);

iii) the variable related to the *level of product quality performed by the firm with respect to competitors' performance* points out how the firm performs in relation to the market quality standards. This variable has a great importance for small firms but it could not be significant for describing the internal configuration of large companies: in particular, in the short term small firms can achieve and sell products with a low quality of conformance by developing a cost based strategy aimed at customers that accept a lower product quality to have a premium price; on the contrary, it is not likely that the market absorbs large quantities of products with a low quality of conformance. Hence, taking into account that the growing level of competition leads small firms – over the long run – to reduce costs and, at the same time, to improve product quality, in this section we aim at identifying most suitable quality related priorities within different contexts characterized by the achievement of a *low* product quality.

In the following we analyse how the small firm's internal configuration – defined in terms of the market turbulence, managers' competencies and the level of product quality performed by the company – affects the effectiveness of different quality based programs.

Proposition 6: in small firms characterized by limited managers' skills, the adoption of training investments represents an effective solution.

Training investments play a central role in small firms: within these companies the entrepreneur is also the chief executive and usually deals with managerial issues according to a technical perspective; in this sense, investments aimed at developing the quality culture at the level of the top management are effective.

Only when a sufficient level of managers' competencies is achieved, the adoption of further quality based investments is effective since new quality programs can be easily accepted by employees and imply a real economical advantage for the firm.

Proposition 7: small firms that achieve a product quality consistent with the competitors' one can improve their competitive position by adopting pro-active strategies.

Many researches suggest that one of the main change agents for stimulating the companies' quality improvement are demanding customers. In our opinion, small firms can not simply conform with customers' requirements because they have some disadvantages with respect to large companies – related to less effective inbound and outbound logistics and to an inferior brand image –; they have to take advantage of the low standardization of their operating processes and of the easiness of internal communication (i.e. flexibility of the organizational structure) to anticipate competitors by, for instance, defining innovative services incorporated with the product or by designing products with an higher quality performance.

Hence, the implementation of design related investments or of programs aimed at improving the firm's capacity to identify new future customers' needs can improve the small firms' market share.

Proposition 8: small firms that achieve a product quality lower than market standards – i.e. the inconsistency of product characteristics to customers' requirements – can successfully implement market and design related investments.

The gap between the product design specifications and customers' requirements can be exceeded by:

- modifying the key product performance according to the market needs: in this sense, market related investments are important; and
- identifying new product design specifications in order to meet customers' requirements, thus leading the firm to implement design related programs.

Proposition 9: small firms that achieve an high rate of defective products have to implement training or inspection and technology based investments.

In fact, the high rate of defective products is usually due to:

- inadequate procedures: hence, training investments contribute to improve the company's quality performance; or
- ineffective equipment: in this case, the purchase of the new equipment represents the only tool for improving quality related performance. In particular, the adoption of technology based investments is a priority apart from the availability of financial resources since firms that do not introduce initiatives aimed at improving their low product quality will leave the market.

On the contrary, in technological contexts where the purchase of new equipment does not improve process and product quality, investments in inspection are the only feasible solution for improving the company's quality performance.

Proposition 10: in turbulent contexts, investments requiring a small cash outlay and aimed at rationalizing the company's operating procedures – i.e., for instance, training programs –, should better contribute to improve the small firm's competitive position.

The high market turbulence means that technologies become soon out of date, and, for this reason, frequent investments in new technologies are necessary; in relation to limited financial resources of small firms, this implies that the implementation of investments requiring a small cash outlay is favoured.

Proposition 11: in high turbulent contexts, design related investments represent a promising solution.

The continuous changes of customers' needs engender short product life cycles: hence, within turbulent markets, firms need to design products that meet customers' requirements and generate the needed financial resources for introducing future new products requested by customers. In this sense, the company's capability to conform with customers' needs represents a critical managerial issue for small firms operating in markets characterized by frequent modifications of customers' needs.

3.4. *The global framework*

Finally, we analyse the combined impact of all sets of variables; we follow a hierarchical approach;

i) at a former level (Figure 2a), we consider binding force of regulations, customers' bargaining power and managers' competencies; hence, we define:
   - *compulsory environments*, where, because of the high customers' bargaining power and/or high binding force of regulations, all the required investments must be implemented and contribute to improve the firm's profitability (proposition 1); in such a context, we do not need to develop further analyses. Compulsory environments are typical of the aeronautics and nuclear fields;
   - *non quality oriented firms*, where the adoption of training investments represents the first step for implementing other quality based investments (proposition 6). This environment refers to small companies that operate in the field of commodities and adopt a cost based strategy applied to customers more interested to low product cost than high product quality.

ii) At a latter level, all contexts are characterized by good technical and managerial competencies. We identify 8 non compulsory contexts (Figure 2b), each one described in terms of:
   - the type of bargaining power of the firm vs. suppliers,
   - the market turbulence and the level of product quality performed by the company.

Fig. 2a. The identified contexts and the variables of the former level.

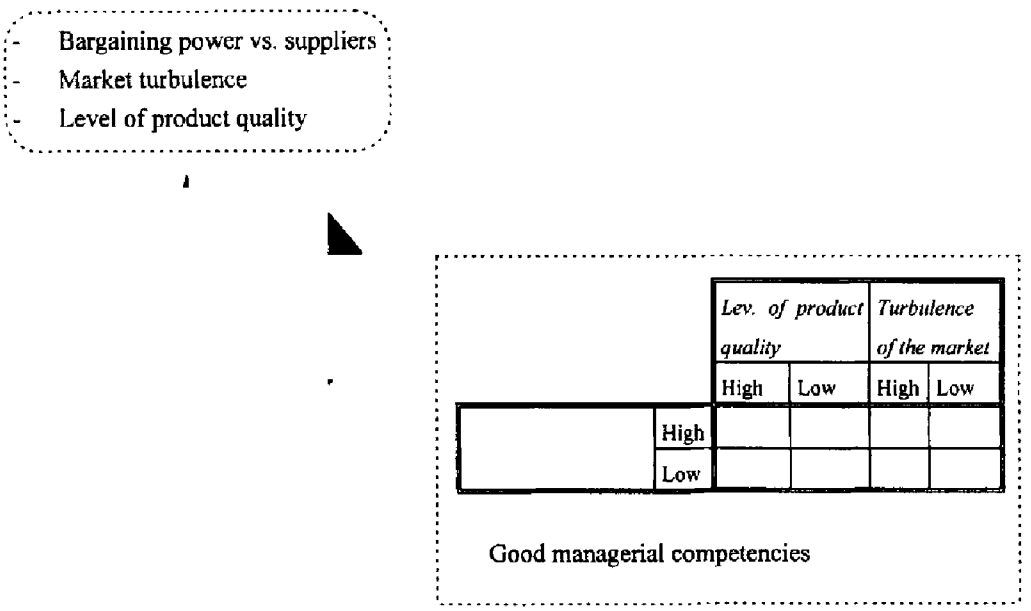

Fig. 2b. The identified contexts and the variables of the latter level.

Context 1

In this context the small firm has high bargaining power vs. suppliers, it performs a product quality rate consistent with competitors' standards and it works in a stable market.

According to:

- proposition 3, the adoption of investments in quality of supplies could be suitable;
- proposition 7, the implementation of pro-active strategies, for instance, based on investments in market/design related investments, should improve the firm's economical performance.

More precisely, by analysing mutual influences among variables that describe this context, we have to consider that:

- in a stable market, initiatives aimed at better identifying customers' needs (market related investments) are not necessary and, for this reason, the implementation of design related investments presents a low priority;
- investments in quality of supplies are important as they allow firms to transfer a share of the quality costs to suppliers; nevertheless, they do not have an high priority because of the market stability: in fact, in such a context we do not need to introduce programs aimed at improving the supplier's quality system (as, for instance, co-makership) since they require useless utilization of financial and human resources;
- investment in product certification has an high priority; in fact, i) the achievement of a product quality rate consistent with customers' requirements and competitors' performance and ii) the market stability makes it easier the adoption of product certification.

This context is, for instance, typical of small firms operating in the industry of footwear or in

the field of automotive components: such companies have high bargaining power vs. suppliers and, at the same time, work in fields where technological processes develop according to foreseeable patterns. Moreover, we have empirical evidences of these contexts in the textile field where small Italian firms greatly depend on the Chinese suppliers especially as regards silk.

Context 2
This context differs from context 1 because it is highly turbulent. The market turbulence makes less important the product quality of conformance than the efficiency in the identification of customers' needs. According to i) propositions 3, 7 and proposition 10 – that enlightens the effectiveness of the implementation of training and design related investments in turbulent market –, and to ii) mutual influences among variables describing the context, we point out that:

- the implementation of technological based investments could have a marginal importance;
- design related investments and initiatives aimed at identifying new customers' requirements (proposition 7) could be a suitable pro-active strategy and they have an high priority;
- the implementation of investments in quality of supplies (proposition 3) presents high priority: in fact, such initiatives allow the company to establish co-makership based relationships aimed at accelerating the flow of information between the firm and its suppliers;
- the adoption of design related investments (proposition 11) has high priority, as it allows the company to conform product design specifications and operating procedures with the market evolution;
- the implementation of training investments contributes to improve the firm's profitability (proposition 10) but it has a low priority.

Moreover, we have to consider that within turbulent markets the cash outlay needed for investment implementation represents a critical variable: for this reason, investments that require limited financial resources are more effective as they usually have a shorter pay back time.

We can not easily find examples of small firms operating in contexts with the above characteristics: in fact, these are peculiar of multinational firms that work in the aeronautic and aerospace fields because of the high bargaining power of firms and of the high turbulence of technological patterns.

Context 3
In this context small firms have high bargaining power vs. suppliers, they achieve a level of product quality not consistent with competitors – i.e. they realize a higher percentage of defective products than main competitors – and work in a stable market. According to propositions 3, 4, and proposition 9, pointing out that the implementation of inspection and technology based investments is effective, we enlighten that:

- programs aimed at improving quality of supplies have a minor importance due to the market stability: in fact, because of the high bargaining power of the firm with respect to external stakeholders, suppliers have to conform their quality related performance with i) market standards or ii) the firm's requirements;
- investments in inbound inspection (proposition 9) are not suitable since the company's high bargaining power vs. suppliers allows the firm to transfer inspection costs to suppliers; equally, investments in on-line and outbound inspection (proposition 9) allow the firm to improve its quality related performance but they do not have an high priority because they do not remove main causes that lead the company to achieve defective products;
- technology based (proposition 9) investments have an high priority in order to conform the firm's quality related standards with competitors' performance: in particular, we assume that the identification of customers' needs and of product design specifications do not represent critical managerial issues because of the market stability;
- training investments are an effective solution when product defectiveness follows from insufficient employees' skills but they do not have an high priority since the low market turbulence does not give a great importance to employees' skills.

The market stability, the high bargaining power of firms and the low level of product quality performed by these companies are partially in

discrepancy: in fact, the characteristics of the external environment and the main relationships with external stakeholders should favour the achievement of an high level of product and process quality; however, from a general viewpoint, small firms that are in the start up phase as regards the introduction of a new type of product operate in contexts that are similar to context 3 above defined.

Context 4
This context differs from context 3 for the high market turbulence. Training and design related investments and investments in quality of supplies have an high priority; on the contrary, technology based investments present a low importance, especially if the firm needs a great amount of money for investment implementation. Moreover, market based investments (low priority) can improve the firm's competitive position, since they are aimed at identifying the change of customers' needs.

We find empirical evidences of these contexts within firms that have an high bargaining power vs. suppliers but perform a product quality lower than competitors in order to develop a strategic choice aimed at reducing the product cost.

Context 5
In this context a small firm has low bargaining power vs. suppliers, it achieves a product quality consistent with competitors and operates in a stable market. Context 5 differs from context 1 for the bargaining power of the firm vs. suppliers; hence, investments aimed at improving operating procedures and at purchasing new equipment have the same importance. With respect to context 1, we only point out that investments in quality of supplies do not greatly improve the company's quality related performance, whilst investments in inbound inspection aimed at avoiding suppliers' opportunistic behaviours are effective because of the company's low bargaining power vs. suppliers.

According to the above issues, it emerges that, for instance, companies producing watches operate in competitive environments similar to context 5: they have low bargaining power with respect to suppliers of cogwheels that have patented their components and, hence, manage the market according to their strategies.

Context 6
This context differs from context 2 for the company's low bargaining power vs. suppliers; hence, according to proposition 5, the following investments improve the firm's competitive position:

- technology based investments (low priority),
- investments in system certification (low priority),
- training programs (low priority),
- design related investments (high priority), and
- inspection based investments aimed at transferring appraisal costs of inbound inspection to suppliers (high priority).

Due to the high market turbulence investments requiring few financial resources are favoured.

Small firms operating in the electromechanical field have relationships with external stakeholders and operate in an environment with characteristics similar to context 6: this field is characterized by an high rate of product and process innovation and companies have usually a low bargaining power with respect to external stakeholders. Moreover, small firms that realize hardware and depend as regards central process units on great multinational groups as, for instance, INTEL can be considered within context 6.

Context 7
In this context small firms have low bargaining power vs. suppliers, they perform a level of product quality not consistent with competitors' performance and work in a stable market. Hence, according to issues developed for context 3 and to proposition 3, the following investments should improve the company's profitability:

- training investments (low priority),
- inspection related investments (low priority), and
- technology based investments (high priority).

Such situation is consistent with the case of companies that develop a niche based strategy aimed at achieving a low product cost.

Context 8
This context differs from context 4 for the company's low bargaining power with respect to suppliers; hence, according to issues developed for

context 4 and proposition 3, technology based programs (low priority) and training, inspection and design related investments improve the company's quality performance.

Due to frequent changes of customers' needs the amount of money needed for investment implementation is a significant issue to justify the effectiveness of different quality related programs.

We can find examples of firms operating in a similar context within fields characterized by low entry barriers and by frequent innovations: due to the low entry barriers, small firms can operate without achieving economies of scale; moreover, taking into account that these fields are characterized by frequent innovation it is likely that small firms achieve a low product quality.

3.5. *Quality related priorities within different contexts*

Table I shows that no quality based related investment is a suitable option in all the identified contexts; more precisely, we point out that:

- design related investments are very important as they are effective in 6 of the 8 contexts. This is consistent with Total Quality Management philosophy which enlightens – to decrease quality costs – the importance of anticipating quality related problems in the early phases of product development (Newall and Dale, 1991; Saccani, 1990);
- the same issues developed for analysing design related investments can be introduced for training investments;

TABLE I
The contexts

Context	Most effective investments	Examples
1	» Design related investments (low priority) » Inv. in quality of supplies (low priority) » Certification based invest. (low priority)	Small firms operating in the industry of footwear, in the field of automotive components and in the textile field
2	» Technology based invest. (low priority) » Inv. in quality of supplies (high priority) » Training investments (low priority) » Design related investments (high priority)	Aeronautic and aerospace industry
3	» Technology based invest. (high priority) » Inv. in quality of supplies (low priority) » Training investments (low priority)	Small firms in the start up phase
4	» Technology based invest. (low priority) » Inv. in quality of supplies (high priority) » Training investments (high priority) » Design related investments (high priority)	Small firms focused on cost leadership
5	» Inspection related invest. (high priority) » Inv. in quality of supplies (low priority)	Small firms operating in the industry of watches
6	» Technology based invest. (low priority) » Inv. in system certification (low priority) » Training investments (low priority) » Design related investments (high priority)	Small firms in the electromechanical field and in the industry of consumer electronics
7	» Inspection related invest. (high priority) » Technology based invest. (high priority) » Training investments (low priority) » Inspection related invest. (low priority)	Small firms focused on cost leadership
8	» Technology based invest. (low priority) » Training investments (low priority) » Inspection related invest. (high priority) » Design related investments (high priority)	Small firms operating in industries with low entry barriers and frequent innovation

- technology based programs are effective when the product quality performed by the firm is low and the competitive environment is stable; in the other cases the financial dimension of the investment represents a critical variable;
- inspection and testing related investments are suitable for small firms that have a low bargaining power vs. suppliers: in fact, in these contexts the quality of raw materials/component could represent a significant problem for the firm, thus pointing out the effectiveness of such investments. On the contrary, when a firm has an high bargaining power vs. suppliers, the adoption of investments in quality of supplies better contributes to improve the firm's competitive position.

4. The selection of the most effective quality based program

This section synthetically analyses state of the art models for final selection, once the most effective quality related priorities have been identified. More precisely, in the following we refer to models that are not specifically designed for investment appraisal in small firms; nevertheless, we believe that, because of the high complexity of quality based investments, we have to refer to complete models that consider both tangible and intangible effects resulting from the implementation of different quality based programs. In fact, once identified the most suitable quality related priorities, the decision maker can develop models aimed at investment appraisal for a limited set of alternatives and, hence, he has to take into account a smaller database.

4.1. *A comparative analysis of state of the art models*

We can select the most effective quality based program among the set of the identified priorities by implementing:

- modified Net Cash Flows based models (Carbonelli *et al.*, 1992; Noci, 1993), or
- scoring techniques (Bromwich and Bhimani, 1991; Nelson, 1986).

Modified Net Cash Flows based models compare different alternatives according to their contribution to shareholders' value; with respect to NPV, they consider items – most of them of qualitative nature – that allow the decision maker to take into account intangible effects resulting from the implementation of each quality based program (Carbonelli and Noci, 1992; Noci, 1993). Within scoring systems, we refer to a particular tool called Strategic Investment Appraisal (Bromwich and Bhimani, 1991). It is the most complete model among methods that compare different alternatives according to a weighted score; in particular, it suggests an analysis that considers three different categories of measures: the first one is related to items that are comprehended in traditional DCF techniques; the second category refers to the items that can be traduced in monetary terms only by introducing some assumptions; finally, the third category identifies scores that can not be converted in monetary terms.

In the selection of the most effective model for investment appraisal, we have to consider that, within small firms, the traditional trade-off between precision of the analysis and cost of model implementation is even more critical than in large companies; in fact, in some cases the limited managers' competencies as regards investment appraisal and limited databases do not allow companies to develop analyses that consider all the effects resulting from the implementation of different quality based programs. Hence, we aim at comparing different models in terms of *precision and cost* of the evaluation; in particular, by precision, we mean the capacity of the model to discriminate among a set of feasible alternatives; by the cost of model implementation, we mean i) the cost for gathering information related, for instance, to cost of people involved in the decision making process and ii) the computational cost to model the problem, cost of software development, run time of computers, etc.

In relation to the requirement of precision, we point out that Net Cash Flows based models develop a more precise analysis than the Strategic Investment Appraisal method; in fact, they introduce a single index expressing how each quality based program contributes to shareholders' value and consider all cost and revenue items; on the contrary, the Strategic Investment Appraisal method does not suggest a single index pointing

out economic value creation resulting from investment implementation: for this reason, we can not easily identify the most effective alternative among a set of feasible quality based programs.

As regards cost of model implementation, Strategic Investment Appraisal performs better than modified Net Cash Flow based models since it requires less information and it does not introduce complex relationships describing the linkage between firm's quality related performance and costs/revenues (Noci, 1995).

4.2. Identifying the most effective technique within different contexts

To identify under which conditions each model is more effective, we have to analyse whether variables describing each context – i.e. "the company's bargaining power vs. suppliers", "the level of product quality performed by the firm in comparison with competitors" and "the turbulence of the market" – privilege specific performance of decisional tools (i.e. precision of the model or cost of its implementation).

To this end, we point out that (Figure 3):

1) the type of "bargaining power of the firm with respect to its suppliers" does not lead us to develop any specific model, as it affects completeness of the evaluation that is a requirement equally respected by state of the art models. Different attributes of this variable affect the number of factors on which the final outcome depends; in firms with high bargaining power vs. suppliers, for instance, the decision maker has to consider more issues than in other competitive contexts: in fact, quality priorities – as investments aimed at improving the efficiency of suppliers' quality system – affect the company's quality performance though they are implemented in an another firm;
2) "the level of quality performed by the firm with respect to competitors" affects precision. When the level of product quality is consistent with competitors' standards and customers' needs, it is more difficult to discriminate among different alternatives since the effects of each quality related option are more intangible and are usually related to the costs of lost sales due to low product quality of conformance: nevertheless they must be considered for developing a complete analysis;
3) "the market turbulence" affects both precision and cost of model implementation: in fact, in turbulent contexts the adoption of complex approaches that need a great amount of data and high computational time is not feasible. Hence, we have to implement models that achieve a good precision and do not need high computational time; on the contrary, models that develop the finest precision but have an high cost of implementation cannot be successfully implemented.

Hence, according to the features of each method and to main decisional requirement/s within different contexts (Table II), we suggest that:

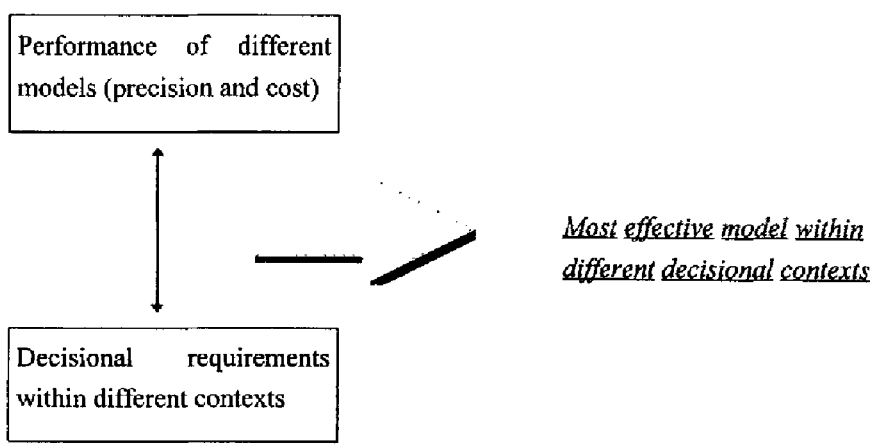

Fig. 3. The suggested approach for identifying the contexts of most effective implementation of state of the art models.

TABLE II
The area of most effective implementation of state of the art models

Context	Decisional requirement/s	Most effective decisional tool
1	Precision of the analysis	Modified NCF models
2	Precision and cost of the analysis	Strategic Investment Appraisal or Modified NCF models
3	Precision of the analysis	Modified NCF models
4	Precision and cost of the analysis	Strategic Investment Appraisal or Modified NCF models
5	Completeness and precision	Modified NCF models
6	Cost of model implementation	Strategic Investment Appraisal
7	Completeness and precision	Modified NCF models
8	Cost of model implementation	Strategic Investment Appraisal

- in contexts 1 and 3, identified by market stability and a product quality consistent with customers' needs, the modified Net Cash Flows models represent the most effective solution as they develop the most precise analysis;
- in contexts 2 and 4, both the modified Net cash Flows models and the Strategic Investment Appraisal approach can be implemented; in particular, the choice between the two methods depends on the importance of the quality related problem under evaluation: specifically, when the decision refers to systemic investments the modified Net Cash Flows models must be adopted, though the turbulent context, as they allow managers to achieve a more precise analysis;
- in contexts 5 and 7 both Strategic Investment Appraisal and the modified Net Cash Flows techniques approach represent effective solutions: in such contexts, in fact, we can easily develop a precise and complete analysis because of i) the low bargaining power of firm vs. suppliers and ii) the low level of product quality performed by firms;
- in contexts 6 and 8 the Strategic Investment Appraisal technique allows managers to establish the better compromise between precision of the analysis and cost of its implementation: in fact, in these contexts, the main objectives of the decision maker are i) to develop analyses that do not require high computational time and costs – because of the high market turbulence – and, at the same time, ii) to implement evaluations with a sufficient level of precision.

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