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ABSTRACT

This paper presents a quantitative study carried out on more than 200 manufacturing plants located in Italy. The study aimed to explore whether small-to-medium sized enterprises (SMEs) in Italy are more responsive than large enterprises and determine what are the levers that these enterprises would employ to achieve their responsiveness. *Logistic responsiveness* has been considered a key driver of competitiveness. Several studies have suggested that company's size is a major determinant of responsiveness and that SMEs have both strengths and weaknesses that influence their ability to promptly react to customer needs. The evidence of this study indicates that SMEs are more responsive than large companies in terms of delivery. This performance advantage is mainly the result of a rather narrow product range and a simpler product structure that allows SMEs to enjoy shorter manufacturing and assembly lead times. On the other hand, this study also shows that SMEs perform worse than large enterprises with respect to longer set-up times.

Keywords: responsiveness; flexibility; plant performances; SMEs

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1. INTRODUCTION

In recent years, the ability to promptly react to customer needs has been considered a major source of competitiveness. The concept of *responsiveness* has been examined from several perspectives, from which researchers have tried to define its determinants, benefits that it can produce and conditions that enable a company to be responsive. Within this body of literature, it has been suggested that small-to-medium sized enterprises (SMEs) can be more responsive than large companies, due to some structural features that make them inherently more flexible, namely a flatter organizational structure and experienced workers. However, it has also been highlighted that SMEs suffer from several constraints, which can keep them from improving some operating performances that influence responsiveness. In particular, a structural lack of human and financial resources can keep smaller companies from implementing up-to-date technologies and practices that can produce a major impact on plant flexibility and responsiveness.

On the basis of the literature review, this paper presents an empirical study that explores whether SMEs are more responsive than large enterprises and, if so, what means they use to reduce their delivery times. In previous works, responsiveness has been examined from several perspectives taking mainly into account *volume*, *products* and *processes* (Holweg, 2005). In this study, we focus on the third perspective, and specifically the delivery process and *logistic responsiveness*. The statistical analysis has been conducted using the database of the Italian Best Factory Award (BFA), a benchmarking survey that served as our source of accurate and up-to-date information on Italian plants. Two sample sets were pooled from the Italian BFA data, one for SMEs and one for large companies. In the first step of our study, we have compared the logistic responsiveness of SMEs with the one of large plants and have explored whether the former actually enjoy a superior speed of delivery than the latter. In the second step, a path analysis has been conducted on the SME sample to gain a deeper insight in the determinants of logistic responsiveness for these companies.

The remaining of the paper is organized as follows. We start with a literature review, which highlights previous contributions on the determinants of logistic responsiveness and on the particular strengths and weaknesses of SMEs that can influence their ability to promptly react to customer needs. Then, the research questions and the methodology are described and the data analysis is presented. The paper concludes with presenting the main managerial implications and conclusions that can be drawn on the basis of the results obtained through the empirical analysis.

2. LITERATURE REVIEW

Responsiveness has been defined as the ability of a company to timely and effectively react to threats and opportunities, so as to maintain or to establish competitive advantage (Barclay *et al.*, 1996). The relevance of such performance has been stressed during the 90s, due to the diffusion of the principles of time-based competition (Blackburn, 1991) that has underlined the necessity to quickly react to customer needs, speeding up both the new product development process and the order fulfillment one (Sin and Hoon, 1996).

The concept of responsiveness has been studied in the academic literature primarily from the following three perspectives (Kritchanchai and MacCarthy, 1999):

- factors that drive companies to be responsive;
- benefits deriving from responsiveness;
- conditions and capabilities that enable a system to be responsive.

As far as the first and the second perspectives are concerned, most contributions belong to the research stream of time-based competition literature and, as such, they underline the relevance of establishing the competitive advantage on time superiority (Azzone and Masella, 1991; Stalk and Hout, 1990), in order to successfully cope with the ever increasing dynamics in customer needs (Sin and Hoon, 1996) and with the challenges deriving from global competition (Barclay *et al.*, 1996).

Studies on the third issue have pointed out several factors that can play a key role in the ability to be responsive. From an operations management perspective, the most relevant dimensions of responsiveness concern *volumes*, *products* and *processes* (Holweg, 2005). These three dimensions concern the ability to modify production volume so as to easily chase demand, to renew product range through the rapid introduction of new models and, finally, to quickly manufacture and deliver items. Focusing on the third dimension, several studies in the operations management literature have analyzed the determinants of the speed of delivery. Holweg (2005) claims that the three dimensions of responsiveness can influence one another. In this concern, the ability to rapidly renew products (leveraging both their internal and external variety) and to modify production volumes can be associated with superior process responsiveness. Furthermore, Holweg asserts that speed of delivery is directly influenced by production lead times and by the decoupling point. Several studies over time have examined such relationships. Vollmann et al. (1997) have proposed a classification of the production planning approaches according to which different production typologies exist (i.e. make to stock, make to order, assemble to order and engineer to order), whose adoption depends on customer's willingness to wait. Other studies have analyzed the impact that the position of the decoupling point can have on companies' performances and organization (Harrison and Skipworth, 2008; Skipworth, 2004).

The relationship among lead times, decoupling point and logistic service has been explored also by a number of studies concerning supply chain design. Namely, the cornerstone contribution of Fisher (1997) has highlighted that, especially for innovative products (e.g. fashion items), characterized by a very unpredictable demand and by high margins, companies must speed up the whole logistic process, from sourcing to delivery, so as not to lose sales opportunities without holding too much inventory. These concepts have been further developed through the proposal of new supply chains models, namely the *lean*, the *agile* and the *leagile* ones (Mason-Jones et al., 2000), in which the strong relationship among decoupling point, lead times and logistic service is strongly emphasized.

On the basis of these papers, the following proposition can be stated:

Proposition 1: Logistic responsiveness is influenced by the position of the decoupling point and the setting of lead times.

While the decision concerning the decoupling point is mainly a strategic one, influenced by the market positioning of the company and by clients' willingness to wait (Vollmann et al., 1997), lead times can be deeply influenced by factors, most of which are under the control of production managers. Namely, production lead times depend on product variety and complexity (Hua et al., 2008; Jordan and Graves, 1995) and on operating flexibility, mainly measured in terms of set-up times (Ben-Daya and Hariga, 2003; Mileham et al., 1999; Slack, 1987). As a matter of fact, several studies have addressed the issue of logistic responsiveness from the perspective of plant flexibility. According to Wahab (2005), contributions on flexibility can be divided into two groups: one encompasses studies on the quantitative measurement of such performance, while the second has a qualitative approach and tries to detect its determinants. Focusing on the second approach, Slack (1987) has proposed a hierarchical model according to which the flexibility of the total manufacturing system depends on the flexibility of each structural and infrastructural resource of the plant itself. These, in turn, are influenced by three types of operational flexibility related to technology, labour and infrastructure. In his framework, Slack (1991; 1987) has also highlighted the conceptual relationship among the responsiveness of an operating system and the determinants of plant flexibility.

The emphasis that Slack gives to technology and workforce can also be observed in other contributions related to the impact of best practices and modern flexible production technologies on corporate responsiveness. Several studies have pointed out the need to rely on flexible production equipment, on multi-skilled workers, as well as on excess manufacturing resources as key conditions to increase corporate responsiveness (Mileham et al., 1999; Bozard and Chapman, 1996; Womack et al., 1990). This correlation has been proved also from the perspective of set-up times, which is a major indicator of operational flexibility. In fact, it has been demonstrated that they are likely to be shorter in manufacturing environments that enjoy favorable operating conditions, mainly related to the implementation of up-to-date production technologies and practices, which play a major role in the improvement of several plant performances, namely workforce flexibility (Pil and Fujimoto, 2007; Slack, 1987), production lines efficiency (Muchiri and Pintelon, 2008; Nakajima, 1988), product quality (Womack et al., 1990) and time to market (Starbek and Grum, 2002).

These evidences can be summarized in the following propositions:

Proposition 2: The setting of production lead times depends on the levels of product variety and complexity and operating flexibility.

Proposition 3: The implementation of modern technologies and best practices safeguard the achievement of operating flexibility in terms of set-up times.

Some of the aforementioned peculiarities are often attributed to SMEs that generally enjoy, compared to larger companies at least, a remarkable speed of the decision making processes due to a rather flat organization structure (Starbek et al., 2002) and also to the presence of production employees endowed with technical skills, whose experience is often a relevant source of innovative ideas (Henny and Albaladejo, 2002; De Toni and Nassimbeni, 1996). On the opposite side, several studies highlight a number of structural problems of SMEs that prevents them to gain remarkable results in some key operational performances, as delivery reliability and conformance quality (Cagliano and Spina, 2002). Cagliano et al. (2001) have examined the adoption of world class practices by European SMEs. They found that firm size was linked to the difference in the use of practices. In particular, practices that are more correlated to size are strategic planning and control, human resources management, equipment layout and preventative maintenance. Smaller SMEs tend to focus on operational aspects while bigger ones are more concerned with strategic planning, business formalization and control and human resource exploitation. Also Mole et al. (2004) have found that the size of the SME has a positive impact on the adoption of what the authors called *soft process technologies* (e.g. total quality management, kaizen and statistical process control). Voss et al. (1998) examined the differences in world class practices between European SMEs and subsidiaries of large companies. They found that the subsidiaries have a much higher level of use of practices compared to SMEs, especially employee involvement, training and education and preventative maintenance.

Building on the aforementioned contributions that analyze SMEs' weaknesses, the following proposition can be stated:

Proposition 4: The responsiveness of SMEs can be constrained by their inability to invest in modern technologies and best practices which could positively influence their operating conditions.

3. RESEARCH QUESTIONS AND METHODOLOGY

Based on the literature review, it can be stated that SMEs enjoy some features, such as flat organizational structure and experienced workers, which can lead them to be more responsive than large enterprises. However, the analysis of previous contributions on logistic responsiveness has also highlighted that it is influenced by many other performances and operating conditions, whose improvement depends on the implementation of up-to-date technologies and practices. This can negatively affect SMEs' responsiveness, given their structural lack of financial and human resources that prevent them from adopting such tools. Thus, even though a wide literature exists on SMEs, it has not been empirically demonstrated whether they actually enjoy a good level of logistic responsiveness. If so, what are factors and conditions that they leverage to promptly deliver products?

The aim of this paper is twofold and can be captured by the following research questions:

> *Research Question 1 (RQ1): Are SMEs more responsive than large companies from a logistic standpoint?*

> *Research Question 2 (RQ2): What are the determinants of SMEs' logistic responsiveness?*

To address the first research question we have developed the following hypothesis, which is based on Proposition 4:

> *H1: SMEs' logistic responsiveness is negatively influenced by their poor operating conditions, which namely concern workforce flexibility, production efficiency, product quality and time to market.*

In order deal with the second research question, the conceptual model described in Figure 1 has been proposed.

TAKE IN FIGURE 1

This model graphically depicts the main relationships between logistic responsiveness and a wide set of determinants that have been addressed by our first three Propositions. To develop this model and be able to apply it, we state the following hypotheses:

> *H2: Logistic responsiveness depends on the position of the decoupling point, that is to say it is positively correlated to the percentage of "make to stock" production.*
>
> *H3: Logistic responsiveness is negatively correlated to lead times.*
>
> *H4: Production lead times are positively correlated to product variety and complexity.*
>
> *H5: Production lead times are positively correlated to set-up times.*
>
> *H6: Set-up times are correlated to a bundle of operating conditions, whose improvement is influenced by the implementation of updated technologies and best practices. Such conditions concern workforce flexibility, production efficiency, product quality and time to market.*

These hypotheses have been directly derived from the above mentioned Propositions. The links among Research Questions, Hypotheses and Propositions are summarized in Table 1.

TAKE IN TABLE 1

In order to investigate these issues, an empirical study has been carried out using the database of the Italian BFA. This is a benchmarking program launched in 1992 by the Cranfield School of Management and later introduced in Italy and in Germany. Its aim is to monitor the performances of local plants, so as to recognize and reward manufacturing excellence of best performing factories on a national basis. To enter the program, manufacturing companies have to complete a questionnaire that contains nearly 200 questions, which can provide an in-depth picture of company's structure and organization, of its competitive and manufacturing strategy, of the best practices and managerial tools employed at the shop-floor level and, finally, of the operating performances reported by the plant. Questionnaires are collected on a yearly basis and, at the end of the process, data are analyzed so as to identify a short list of best performing plants. They are eventually visited by a judging panel, which validates questionnaire data and observes the organizational practices and solutions that determine outstanding performances. At the end of the visits, the panel selects the factories that deserve an award. As extensively reported by New and Szwejczewski (1995), one of the main benefits of the BFA concerns quality of data. Companies that want to enter the BFA are requested to provide the results actually achieved and not a generic self-assessment on a Likert scale, namely for operating performances. This makes it possible to obtain a detailed database suitable for producing national benchmarks concerning a wide number of performance indicators. Furthermore, data collected through the questionnaires have to be provided by multiple respondents. As a matter of fact, the wide variety of data and information requested to complete the questionnaire makes it necessary to identify, within the company, several managers in charge of supplying them. This sharply reduces the risk of getting biased information. Finally, site-visits of the judging panel have demonstrated over time that data provided by the questionnaires are reliable.

The BFA has generated, in all Countries in which it is carried out, a wide database of operating performances that has been used to perform several quantitative analyses on a national (Grando and Belvedere, 2006, Mapes et al., 2000; Mapes et al., 1997; New and Szwejczewski, 1995) and international level (Szwejczewski et al., 2003; Lemke et al., 2000).

To address the research questions mentioned above, two sample sets of plants of the Italian BFA have been examined. The first concerned large companies - with more than 250 employees, according to a directive of the European Union (96/C 213/04), and encompassed 59 production units. The second concerned 147 SMEs (with less than 250 employees). These sample sets encompassed only factories that perform assembly operations. This choice was led by the fact that the research questions focus on logistic responsiveness, whose determinants are primarily manufacturing and assembly lead times. In assembly operations, they can be easily distinguished and measured. On the opposite, in plants performing process operations, this distinction could be hardly applied.

To measure logistic responsiveness and its determinants a wide set of variables from the Italian BFA database have been employed, as reported in Table 2.

TAKE IN TABLE 2

The first variable (V1) in Table 2 refers the total number of employees, which has been used to distinguish the two samples. All the other variables have been chosen so as to properly quantify the constructs encompassed in the model presented in Figure 1. Namely, logistic responsiveness has been quantified through variables V2, V3 and V4, which measure the shortest, the average and the longest delivery times, as proposed by Holweg (2005) who employs delivery times to assess the ability of a company to rapidly fulfil an order. The choice concerning the position of the decoupling point has been operationalized through variable V5. It measures the percentage of the plant total output supplied to customer off the shelf, i.e. the percentage of make to stock volumes (Vollmann et al., 1997). To identify appropriate measures for lead times, we referred to major contributions namely about supply chain archetypes and strategies (Mason-Jones et al., 2000; Fisher, 1997). According to such stream of research, lead times that can affect the ability to quickly deliver finished products concern the production lead time as well as the procurement one. In the BFA database, the former is quantified through two variables, one concerning the manufacture of components and the other concerning the final assembly of the finished product. Thus, we have employed three variables to measure lead times: V6 for procurement, V7 and V8 for production ones.

Set-up times have been quantified through variables V9 and V10, which measure the average set-up time for components manufacture and for final assembly.

Product variety and complexity have been measured through variables from V11 to V14. Namely, product variety has been observed through V11, which refers to the width of product range. Product complexity has been observed from a manufacturing perspective, thus it has been quantified looking at the total number of items included in the typical bill of materials (V14) and also at the number of items present in the transformation process, which encompasses bought-out materials (V13) and internally manufactured components and sub-assemblies (V12).

Finally, variables from V15 to V19 quantify the main plant operating conditions that are assumed to be correleted to set-up times and that can be influenced by the implementation of best practices and technologies. As maintained by several authors, such practices and technologies can positively affect time to market (Starbek and Grum, 2002), product quality (Womack et al., 1990), production lines efficiency (Muchiri and Pintelon, 2008; Nakajima, 1988) and workforce flexibility (Pil and Fujimoto, 2007; Slack, 1987). We have measured time to market through variable V15. Product quality has been quantified in terms of percentage of customer returns for quality reasons (V16). Production line efficiency has been assessed through the overall equipment effectiveness (V17), which is a widely used indicator for production efficiency. Lastly, to assess workforce flexibility we have used V18 and V19. The former measures the average length of service of employees, which has a strong impact on the scope of activities that workers are able to perform. The latter is an explicit indicator of workforce flexibility and refers to the percentage of employees able to perform more than 50% of the production tasks in their area.

To address the first research question, the average performances reported by the SME sample set have been compared with the ones of large companies so as to explore whether the former are more responsive than the latter and also to compare the operating performances that drive logistic responsiveness. The results of the comparison have been analyzed moving from the assumption reported in H1.

To address the second research question, a path analysis has been conducted on the SME sample set through a series of multiple regressions (Wright, 1960; 1921). Other examples of this method for performing path analysis are Cagliano and Spina (2002) and Rungtusanatham et al. (1998). This analysis has aimed at identifying the most reliable predictors of SMEs' logistic responsiveness and at detecting the determinants that such companies actually leverage to shorten their delivery lead times.

To perform such analysis the variables reported in Table 2 have been organized so as to operationalize the conceptual model reported in Figure 1. In this step of the process, V1 was not used as it is not relevant in the path analysis. Furthermore, to assess logistic responsiveness through a single variable, only V3 was considered, while V2 and V4 have been excluded. In the first step of this study V2 and V4 have been used to provide a more detailed assessment of the responsiveness of both samples. In the second step we have considered the average customer lead time (V3) more representative than the shortest and the longest ones. All other variables have been included in the path analysis. In accordance with what has been explained above and on the basis of Hypotheses H2 and H3, variables from V5 to V8 have been used as predictors of average customer lead time. Then, procurement lead time (V6) and proportion of make to stock production (V5) have not been further investigated through any regression model. As a matter of fact, the former measures a phenomenon that is heavily influenced by exogenous conditions related to the features of the industry and to supplier's performances. The latter, as reported above, is mainly a consequence of a strategic decision influenced by the market positioning of the company and by clients' willingness to wait. On the opposite, the predictors of manufacturing (V7) and assembly (V8) lead times have been investigated. In accordance to Hypotheses H4 and H5, we assume that such lead times are correlated to product variety and complexity and also to set-up times. Namely, the time necessary to manufacture a component can be deeply influenced by the time length of the set-up (V9) and by the variety of the inputs (V13) and of the outputs (V12) of the operation. Similarly, the assembly lead time depends on set-up time (V10), on the complexity of the typical bill of material (V14) – i.e. the input – and on the variety of finished products to be assembled (V11) – i.e. the output.

Product complexity and variety (variables from V11 to V14) depend on strategic decisions concerning the width of product range and vertical integration, thus they have not been further analyzed through any regression. On the opposite, as reported in Hypothesis H6, we assumed that set-up times (V9 and V10) are correlated to (thus can be predicted by) a number of internal operating conditions, measured through variables from V15 to V19.

The cause-effect model of the path analysis is represented in Figure 2.

TAKE IN FIGURE 2

4. Data analysis and results

4.1.The responsiveness of SMEs compared to the one of large plants

Table 3 reports the list of variables used to compare the performances of the two samples, the average values observed and the significance level. For this analysis the Wilcoxon test was used to check whether both samples come from the same population. The Wilcoxon test is used as an alternative to the paired Student's t-test when the populations in questions cannot be assumed to be normally distributed (Mood et al., 1974). Outliers have been visually checked and removed.

TAKE IN TABLE 3

As it can be observed, large companies have on average 583 employees, while such variable in SMEs is equal to 84 (p-value<0.001).

Observing the average value of V2, V3 and V4 it can be stated that SMEs are actually much more responsive than large companies from the logistic standpoint. As a matter of fact, all these three measures of the delivery lead time are lower than those in the sample of large companies, showing a good level of statistical significance. This seems to be due to a higher proportion of make-to-stock production (V5), which in SMEs is equal to 27% while in the other sample it is equal to 19% (p-value<0.05). Furthermore, SMEs enjoy better procurement and production lead times (V6, V7 and V8). Namely, the comparisons for variables V6 and V8 are statistically significant. Although they are responsive from the logistic point of view, SMEs suffer from longer set-up times (V9 and V10) and show a lower product variety and complexity (V11, V12, V13 and V14). Focusing on significant comparisons, it can be observed that the product range (V11) encompasses 1,922 items in SMEs and 2,164 in large companies. Also the variety of manufactured components (V12) and bought-out materials (V13) is lower in small companies, which have 2,825 for the former and 4,596 for the latter, as opposed to large plants that produce on average 4,339 parts and buy 9,862 items. Moreover, the complexity of the bill of material of the main product is sharply different (V14). On average, the finished product with the largest output in SMEs encompasses 212 parts, while in large companies it is made up of 2,394 components.

As far as internal operating conditions are concerned, focusing on significant comparisons, it can be stated that SMEs show both strengths and weaknesses compared to large enterprises. Bringing new products to the market takes 11 months in the former and 21 months in the latter, thus highlighting a higher responsiveness of SMEs as far as the innovation process is concerned. As discussed above, such good performance in the innovation process witnesses a superior organizational flexibility and a strong attitude towards the ability to promptly react to market needs. SMEs also enjoy a better level of employees' flexibility (V19), which further strengthens what has been already claimed about their superior organizational flexibility. However, such evidence is not supported by statistical significance. As far as customer returns for quality reasons (V16), overall equipment effectiveness (V17) and average length of service (V18) are concerned, the comparison with large companies' sample highlights some weaknesses. As a matter of fact, product quality in SMEs is worse than in large companies (p-value<0.05). As far as the overall equipment effectiveness is concerned, large plants outperform smaller ones, even though this comparison does not show statistical significance. Furthermore, large enterprises are able to retain their employees for a longer time than SMEs' (p-value<0.001). These data seem to show that SMEs have not enjoyed most of the positive effects that come from the implementation of updated technologies and practices, which have also a strong impact on set-up times, as already discussed.

Recalling the first Research Question RQ1 and the related Hypothesis H1, it can be stated that Italian SMEs do perform better than large enterprises as far as delivery times are concerned. This time superiority seems to be based on a higher percentage of make to stock production and on shorter lead times. However, as stated in Hypothesis H1, SMEs, compared to large companies, suffer from several worse operating conditions correlated to set-up times, namely customer returns for quality reasons, overall equipment effectiveness and average length of service. On the opposite, this analysis points out that employees' flexibility and time to market are peculiar strengths of Italian SMEs.

4.2.The determinants of SMEs' responsiveness

This study leads to the conclusion that SMEs' are actually more responsive than large plants. However they perform worse as far as most of the determinants of logistic responsiveness are concerned. To gain a deeper insight in this phenomenon, a path analysis was conducted on the SME sample set. To identify possible outliers, the Mahalanobis' distance was computed, which is used for detecting observations which appear to be quite different from the average observations in the data set (Stevens, 2002; 1984). No relevant outliers have been found, thus the whole SMEs sample has been employed.

The results are reported in Figure 3. It indicates the R^2 for each multiple regression and its p-value; for each statistically significant predictor, the Beta weight and the p-value have been provided.

TAKE IN FIGURE 3

Furthermore, we have measured the indirect effect that variables not directly connected to average customer lead time (V3) have on such performance. Table 4 reports these results only for variables with a statistical significant indirect effect, namely V12, V13, V14 and V18.

TAKE IN TABLE 4

The second Research Question (RQ2) of this study aimed to define the determinants of SMEs' logistic responsiveness, moving from Hypotheses H2, H3, H4, H5 and H6. The evidence gained through the path analysis demonstrate that the conceptual model described in Figure 1 (and operationalized as reported in Figure 2) provides a reliable description of the determinants of SMEs' logistic responsiveness. Furthermore, the outcomes of this analysis fully support Hypothesis H5 and partially support Hypotheses H3, H4 and H6.

Reading the results reported in Figure 3 in a top-down manner, it can be observed that the proportion of make to stock production and the lead times account for 84% of the variance of average customer lead time (p-value<0.001). Specifically, manufacturing lead time (V7) and assembly lead time (V8) are reliable predictors of the logistic responsiveness, as their Beta weights show statistical significance. Furthermore, it can be stated that manufacturing lead time, with a Beta weight equal to 0.788, plays a major role than assembly lead time in determining logistic responsiveness. Thus, while Hypothesis H2 is not supported by statistical significance, H3 is confirmed as far as assembly and manufacturing lead times are concerned.

Then, manufacturing and assembly lead times were analyzed through a multiple regression model so as to understand whether they can be predicted by set-up times and product variety and complexity. Variables V9, V12 and V13 account for 68% of the variance of manufacturing lead time (p-value<0.001); furthermore, the analysis demonstrates that average set-up time for a component (V9) and the number of parts manufactured internally (V12) are statistically significant predictors. Similar evidence can be observed as far as the average assembly lead time is concerned. In this case, the multiple regression shows that the average set-up time for assembly (V10), the total number of finished products (V11) and the number of parts encompassed in the main product (V14) account for 43% of the variance of V8. In such regression, V10 and V14 are significant predictors. Therefore, it can be claimed that Hypothesis H5 is fully supported by the evidence, while Hypothesis H4 is partially confirmed.

In the last step of the path analysis, a regression model was tested on both average set-up time for a component manufacture (V9) and the average set-up time for assembly (V10) so as to understand whether variables from V15 to V19 can predict them. The results demonstrate that in both cases such variables account for a major part of the variance of V9 and V10 (71% and 64%). Namely, time to market (V15), customer returns for quality reasons (V16), employees' length of service (V18) and employees' flexibility (V19) are reliable predictors of V9, while only time to market shows a good statistical significance as a predictor of V10. Finally, it is worth noting that all coefficients are in the predicted directions, but for employees' length of service (V18) and flexibility (V19). In fact, it can be observed that they are positively related to the set-up of component manufacture (V9). Furthermore, this unexpected evidence, namely for V18, is also confirmed by the indirect effect of employees' average length of service on logistic responsiveness (V3), which is not in the predicted direction (see Table 4). Then, we can state that Hypothesis H6 is partially supported by these evidences.

5. CONCLUSIONS AND MANAGERIAL IMPLICATIONS

Analyzing the evidence stemming out of our study, it can be observed that Italian SMEs enjoy superior performances in terms of logistic responsiveness. They outperform large companies as far as the delivery times are concerned; furthermore, their strong attitude towards responsiveness can be also observed in the internal lead times. In fact, procurement, manufacturing and assembly lead times of SMEs are much shorter than those of large companies. The relevance that such companies give to the ability to react quickly to customers' needs is also witnessed by their average time to market. In this concern, this study demonstrates that, as already maintained by previous contributions (Henny and Albaladejo, 2002; Starbeck et al., 2002; De Toni and Nassimbeni, 1996), responsiveness - namely the logistic one - is a peculiar strength of SMEs. However, this analysis also highlights some weaknesses of such enterprises that can negatively affect their delivery times, namely related to some operating conditions whose improvement depends on the introduction of modern technologies and practices. In fact, SMEs have long set-up times, which are key determinants of manufacturing and assembly lead times (Mileham et al., 1999; Slack, 1987). Furthermore, some operating conditions and performances, in particular those concerning overall equipment effectiveness, customer returns for quality reasons and employees' length of service, are worse than in large companies. These evidences confirm the Hypothesis H1 that SMEs suffer from poor operating performances, whose improvement depends on the implementation of updated practices and technologies (Mole et al., 2004; Cagliano and Spina, 2002; Cagliano et al., 2001; Voss et al., 1998).

These evidences are strengthened by the path analysis. It demonstrates that namely manufacturing and assembly lead times are relevant and significant predictors of the delivery time, as it can be expected (Holweg, 2005; Wadhwa, 2005). Thus, based on the results of the path analysis, we can claim that SMEs deliver faster than large companies *because* they manufacture and assemble items very quickly. However, this superiority does not rely on a higher internal flexibility, but on narrower product variety and complexity that have a major impact on internal lead items. Also set-up times are significant predictors of internal lead times, but, as the comparison with large companies highlights, they are a weakness of SMEs, which comes from their inability to implement best practices and technologies, such as Single Minute Exchange Die (SMED) and rapid tool setting. This is pointed out by the last step of the path analysis, in which it is shown that operational performances affected by these practices and technologies account for a major part of the variance of set-up times. As it can be observed in Figure 3, the only positive element for SMEs concerns time to market, which positively influences changeovers. This confirms the assumption according to which there is a positive interdependence among the different dimensions of responsiveness that can be due to an overall attitude towards speed in the management of all business processes (Holweg, 2005). Focusing on the set-up time for manufactured components, it can be stated that when product quality is poor also changeovers show unfavorable values. But what is worth noting is the relationship between set-up time for manufactured components, on the one hand, and employees' length of service and flexibility, on the other. In fact, it could be expected that Beta weights should be negative (Henny and Albaladejo, 2002; De Toni and Nassimbeni, 1996), in the sense that the former should be lower when the latter show higher values. However, the outcomes of the path analysis contradict this assumption. This can be due to the fact that, if there is not any change to the managerial practices implemented at the shop floor level - as in the SMEs sample, employees' length of stay can have a negative impact, in that workers keep on performing production activities according to obsolete approaches. In this setting, employees' flexibility can also become a weakness. In fact, if a higher flexibility is due to a lack of specialized production-related workers, flexibility can have an unfavorable effect on the ability to perform more complex activities, as changeovers are.

This outcome highlights some of the fundamental characteristics of the Italian industrial system which is mainly driven by SMEs. As a matter of fact, the value proposition of the SMEs' sample seems to be based on the ability to quickly meet customers' needs in terms of innovation and delivery. However, because they manage a lower product complexity, namely in terms of the number of parts present their typical bill of material, it can be assumed that they are engaged in production networks where they perform a rather narrow set of transformation activities. Thus, the success of such SMEs depends on their ability to take part to complex networks, often coordinated by a focal company that selects its suppliers taking into consideration a wide set of manufacturing and logistics performance variables — in which not only responsiveness, but also product quality, flexibility, dependability and efficiency are crucial parameters (Macpherson and Wilson, 2003). In this concern, Italian SMEs could be threatened by their inability to invest in up-to-date manufacturing practices and technologies that can boost such performances. In an international context, the above mentioned weaknesses can turn a serious handicap for Italian SMEs due to the recent rise of new competitors placed in low-cost Countries, which compete aggressively on product price. Against such new players, an internationally-minded company must either be very effective in differentiating itself through outstanding operating performances, or be efficient enough to stay on the market.

As a matter of fact, large Italian companies, leveraging on their internal efficiency, have recently implemented cost-reduction strategies that brought about noticeable improvements in their profitability. On the opposite, Italian SMEs keep on loosing market share, thus demonstrating their inability to adapt their competitive model to the new and most challenging international realities. From a managerial perspective, the use of effective and time-efficient solutions, as kaizen events, could be a first attempt of Italian SMEs to start introducing modern practices with a rather low effort in terms of financial resources.

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Table 1 – Links among Research Questions, Hypotheses and Propositions

Research Question 1	Research Question 2
Proposition 4 leads to Hypothesis 1	Proposition 1 leads to Hypotheses 2 and 3
	Proposition 2 leads to Hypotheses 4 and 5
	Proposition 3 leads to Hypothesis 6

Table 2 – Variables of the BFA database employed in the quantitative analysis and their links with the conceptual model

Constructs of the model	***Variable***	***Performances and operating conditions***
-	V1	Total employees (number)
Logistic responsiveness	V2	Shortest customer lead time (days)
	V3	Average customer lead time (days)
	V4	Longest customer lead time (days)
Decoupling point	V5	Proportion of the plant total output supplied to customers off the shelf (%)
Lead times	V6	Planned procurement lead time for the main bought out material (days)
	V7	Average manufacturing lead time (days)
	V8	Average assembly lead time (days)
Set-up times	V9	Average set-up time for component manufacture (minutes)
	V10	Average set-up time for assembly (minutes)
Product variety and complexity	V11	Number of items record currently in use within the plant at product level (number)
	V12	Number of items record currently in use within the plant at manufactured component, bulk intermediate or sub-assembly level (number)
	V13	Number of items record currently in use within the plant at bought out component or sub-assembly level, not including raw materials (number)
	V14	Number of different manufactured components, purchased items, feedstock or purchase assembly present in the product with the largest output (number)
Plant operating conditions	V15	Time to market (months)
	V16	Customer returns for quality reasons (%)
	V17	Overall Equipment Effectiveness (%)
	V18	Average length of service (years)
	V19	Employees' flexibility (Percentage of production employees who can carry out more than 50% of the production tasks in their area)

Table 3 –Average performances and operating conditions in large and SME enterprises

Variable	*Performances and operating conditions*	*Large*	*Small-to-Medium*	*p-value*
V1	Total employees (no.)	583	84	<0,0001***
V2	Shortest customer lead time (days)	44.6	14.3	0,0016**
V3	Average customer lead time (days)	91.3	32.0	0,0015**
V4	Longest customer lead time (days)	167.1	66.2	<0,0001***
V5	Proportion of the plant total output supplied to customers off the shelf (%)	19	27	0,0064*
V6	Planned procurement lead time for the main bought out material (days)	122	49.9	<0,0001***
V7	Average manufacturing lead time (days)	21.1	17.3	0,249
V8	Average assembly lead time (days)	19.9	8.7	0,0417*
V9	Average set-up time for component manufacture (minutes)	76	87	0,612
V10	Average set-up time for assembly (minutes)	18	25	0,588
V11	Number of items record currently in use within the plant at product level (no.)	2,164	1,922	0,0186*
V12	Number of items record currently in use within the plant at manufactured component, bulk intermediate or sub-assembly level (no.)	4,339	2,825	<0,0001***
V13	Number of items record currently in use within the plant at bought out component or sub-assembly level, not including raw materials (no.)	9,862	4,596	<0,0001***
V14	Number of different manufactured components, purchased items, feedstock or purchase assembly present in the product with the largest output (no.)	2,394	212	<0,0001***
V15	Time to market (months)	21	11	<0,0001***
V16	Customer returns for quality reasons (%)	0.45	1.1	0,0119*
V17	Overall Equipment Effectiveness (%)	83.4	80.5	0,3933
V18	Average length of service (years)	12.8	9.9	0,0013**
V19	Employees' flexibility (Percentage of production employees who can carry out more than 50% of the production tasks in their area)	60.3	65.4	0,2154

* p-value<0.05; ** p-value<0.005; *** p-value<0.001

Table 4 –Indirect effects on Average Customer Lead Time

Variable	***Performances and operating conditions***	***Indirect Effect on Average Customer Lead Time (V3)***
V9	Average set-up time for component manufacture (minutes)	NS
V10	Average set-up time for assembly (minutes)	NS
V11	Number of items record currently in use within the plant at product level (no.)	NS
V12	Number of items record currently in use within the plant at manufactured component, bulk intermediate or sub-assembly level (no.)	0,501***
V13	Number of items record currently in use within the plant at bought out component or sub-assembly level, not including raw materials (no.)	0,663***
V14	Number of different manufactured components, purchased items, feedstock or purchase assembly present in the product with the largest output (no.)	0,581***
V15	Time to market (months)	NS
V16	Customer returns for quality reasons (%)	NS
V17	Overall Equipment Effectiveness (%)	NS
V18	Average length of service (years)	0,234*
V19	Employees' flexibility (Percentage of production employees who can carry out more than 50% of the production tasks in their area)	NS

* p-value<0.05; ** p-value<0.005; *** p-value<0.001

Figure 1 - The conceptual model

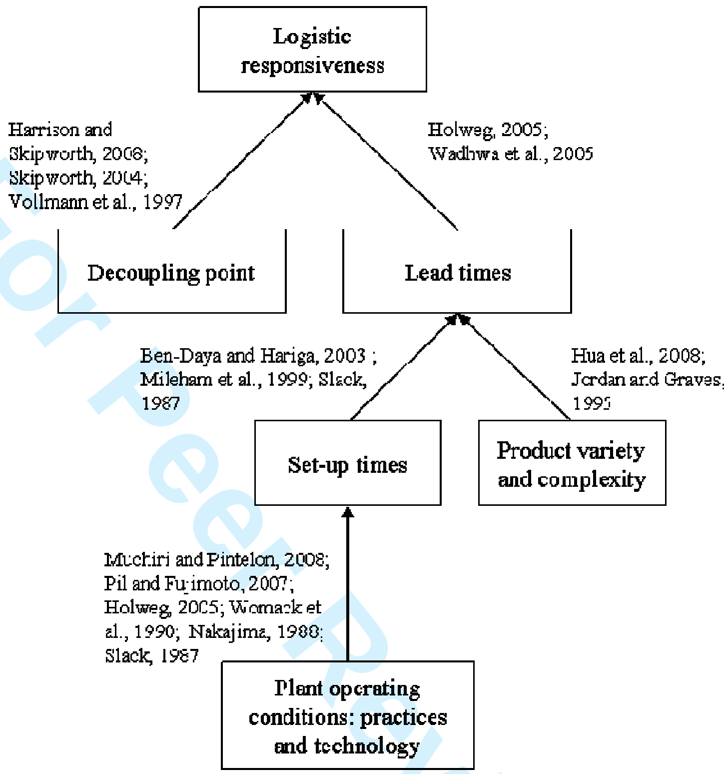


Figure 2 – The path analysis and the cause-effect relationships among BFA variables

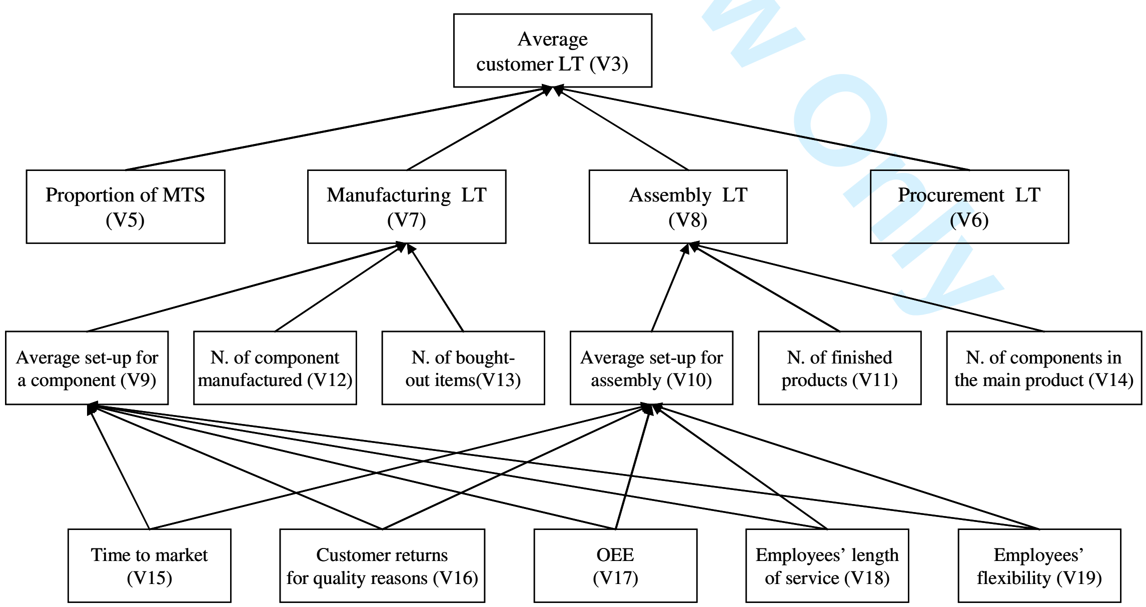
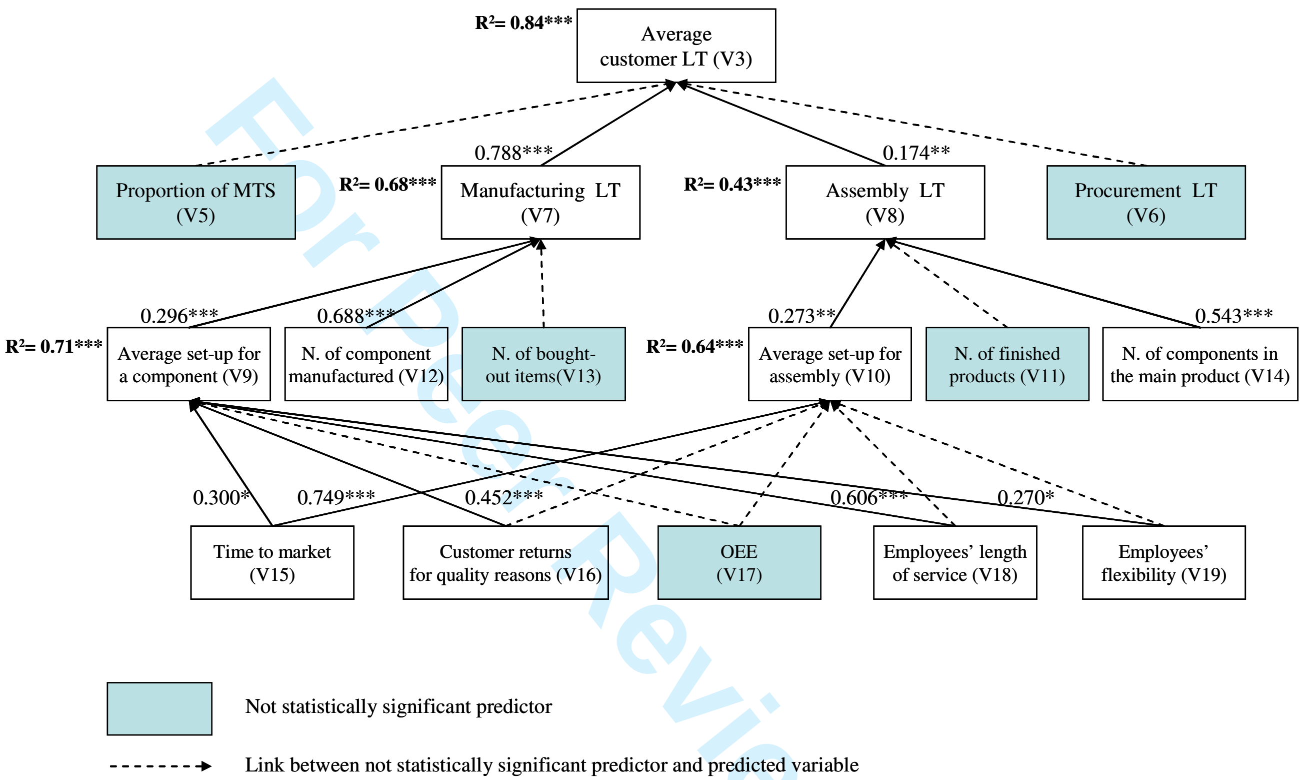


Figure 3 – The path analysis: results



* p-value<0.05; ** p-value<0.005; *** p-value<0.001