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The dynamic relationship between competitive priorities and manufacturing best practices: a longitudinal analysis patterns

by

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The dynamic relationship between competitive priorities and manufacturing best practices: a longitudinal analysis

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Abstract
This work investigates the relationship between manufacturing best practices and competitive priorities. By means of data provided by four editions of the IMSS dataset, a longitudinal analysis is performed to analyze to which extent this relationship is stable over time. Results provide evidence that some best practices have always been adopted to pursue specific goals while others have changed their role over time. This work provides empirical evidence that the role of manufacturing best practices changes over time and it emphasizes the importance for companies to adopt specific practices to pursue clear competitive goals and not simply for imitation.

Keywords: Manufacturing Best Practices; Manufacturing Strategy; Longitudinal Analysis, IMSS

1 Introduction

Literature regarding manufacturing strategy has significantly developed in the last forty years. Contributions in this field evolved around different perspectives of the concept of manufacturing strategy itself, leading to three paradigms (Voss 1995, 2005). First, attention has been devoted on manufacturing as a competitive tool; authors using this perspective argue that the firm should compete through its manufacturing capabilities and thus it should align its capabilities with its key success factors, its strategy and the marketplace. Some authors (e.g., Hill, 1993; Platts and Gregory, 1990) argue that in each market companies should identify those criteria that win orders against the competition. Thus the key issue addressed is that aligning manufacturing capabilities with the key success factors maximizes the firm's competitiveness.

A second paradigm relates to the need for both internal and external consistency between choices in manufacturing strategy (Hayes and Wheelwright, 1984). Here mainly contingency-based approaches can be found as authors argue that choices are contingent on context and strategy (e.g., New, 1992).

Finally, within the best practice paradigm the attention has been placed on those manufacturing practices that lead to best performance, thus research has been focused on identifying and studying what best performers do, in order to disseminate those practices. This area has devoted attention on a wide array of practices such as just-in-time (e.g. Schonberger, 1986), lean production (e.g. Womack et al., 1990) and concurrent engineering (e.g. Wheelwright and Clark, 1992).

This paper focuses on the best practice paradigm. In particular, we aim at considering the contingency and evolutionary nature of best practices. Literature in fact has devoted only limited attention to these two issues; we argue that their relevance is significant for different reasons. First, despite one interpretation of best practice is about their universalistic nature, that is, their ability to lead to superior performance independently from the context in which they are applied, many authors maintained that best practices really depend on the context the company is facing (Powell, 1995; Dow et al, 1999; Ketokivi and Schroeder, 2004). According to this perspective the same practice can be beneficial in some contexts while it can be difficult to be applied or not effective in others. For this reason, the best practice concept needs to be analyzed by taking into account the environment in which a company operates, in terms of market, competition but also in terms of strategic objectives (Voss, 2005). Limited evidence however is provided on this issue, thus this paper aims at contributing to the debate on the contingency nature of best practices. Among the several contingency variables that literature has considered (see Sousa and Voss (2008) for a review of contingency theory in manufacturing strategy), our attention is specifically focused on strategic goals, in particular on the impact of competitive priorities on manufacturing practices.

Another important but rather unexplored stream of research within the best practice paradigm highlighted that best practices evolve over time (Laugen et al., 2005). New practices become available (Flynn et al., 1999) leading to changes in companies' behavior. Besides, the more a best practice is applied by companies, the more it becomes a "common" practice and thus it reduces its competitive advantage. For this reason both best practices may evolve over time but also the reasons why certain practices are applied can change. Unfortunately, literature on this topic is rather sparse; thus this paper aims also at providing a contribution on the evolutionary nature of best practices.

In this work these two issues (i.e., contingency nature of best practices and evolutionary nature of best practices) are put together: specifically we aim at studying whether and how the relationship between strategic goals and practices has evolved over time.

The paper is based on data collected from four editions of the International Manufacturing Strategy Survey, a research project carried out in 1992, 1996, 2001 and 2005 by a global network. This data allows us to investigate the evolution of manufacturing practices over a period of more than ten years in several countries around the world.

The paper is structured as follows. In the next section literature on manufacturing best practices, contingency theory and evolution is provided; then research objectives are detailed and the empirical methodology is described. Following, empirical results are provided and discussed and implications of our results are discussed. The final section provides the conclusions of our work and some future development.

2 Research background

The literature on manufacturing best practices has developed significantly in the last ten years due to the increased interest in benchmarking. Davies and Kochhar (2002) and Laugen et al. (2005) provide detailed reviews of previous works dealing with the relationship between practices and performance.

The basic idea behind the study of best practice is summarized by Laugen et al. (2005):

The basic principle of the best practice thinking is that operations philosophies, concepts and techniques should be driven by competitive benchmarks and business excellence models *to improve an organization's competitiveness through the development of people, processes and technology*. (pag. 132)

Thus the main focus of this stream of research is to analyze the impact of specific practices on performance.

As a matter of fact, however, limited contributions have directly investigated the link between practices adopted by companies and performance. Only few studies confirm that the use of best practices leads to improved performance (e.g., Hanson and Voss, 1993; Voss et al., 1997). Davies and Kochhar (2002) suggest that this is partially due to the difficulty in defining what a best practice is. Usually best practices are considered those that lead to better performance, but some authors suggest that best practice should be defined the other way round: as best practices are those implemented by best performing companies (Davies and Kochhar, 2002; Laugen et al., 2005). In fact best practices should have positive impacts on different performance measures and not simply lead to improvement in a very narrow area of management.

Examples of this are studies focused on single best practices like Total Quality Management (TQM) or Just-in-Time (JIT). Samson and Terziovski (1999) state that some specific TQM practices are related to higher operational performances, measured not only in terms of quality of the output but also: satisfaction, employee morale, productivity and delivery performance. Huson and Nanda (1995) measure the impact of Just-in-Time finding that there is a positive impact on reduction of inventories, increased inventory turnover, quality, labor efficiency and morale.

Other studies (e.g. Flynn and Schroeder) in the so called World Class Manufacturing stream, show that the joint use of traditional and new manufacturing practices (e.g. quality management and JIT) is the most effective in reaching higher operational performances.

Nevertheless some contributions show that the relationship between best practice and performance is not completely straightforward (Powell, 1995; Dow et al, 1999; Laugen et al., 2005). There can be several reasons why this relationship is not empirically confirmed. Voss (2005) suggests that the use of best practice should be investigated within a specific context. This point refers to the fact that the impact of best practices (and in general their applicability) depend on the specific context under investigation. There is in fact evidence that some practices are widely applicable, whilst others are applicable only in specific contexts (Powell, 1995; Dow et al, 1999; Sousa and Voss, 2001; Ketokivi and Schroeder, 2004).

Despite this interest, however, much of the literature is descriptive, presenting practices that successful companies have in place. Even though Operations Management research has moved more and more from an universalistic to a contingency based approach (Sousa and Voss, 2008), limited evidence is provided regarding those factors that determine whether a best practice is appropriate for a specific environment. In fact no single practice works for everyone in any situation (Hiebeler et al., 1998). For this reason previous works have highlighted the need for contingency-based analysis of best practice so to consider properly the context in which the company is operating (Voss, 2005; Dangayach and Deshmukh, 2001).

Sousa and Voss (2008) provide a detailed review of contingency theory in operations management. Contingency variables can be grouped into four broad categories (Sousa and Voss, 2001): national context and culture, firm size, strategic content and other organizational context variables.

Several studies have investigated the impact of national and cultural variables on manufacturing practices. This interest is partially motivated by the fact that some best practices were founded in specific regions (i.e., just in time in Japan). Thus the issue some authors took into account was the extent to which these practices could be transplanted in other areas (e.g. Voss and Blackmon, 1998). Several studies have provided evidence of the existence of contingency effects on practice (e.g., Flynn and Saladin, 2006).

A second group of studies has considered the impact of size. Company size is considered to have an impact since small and medium enterprises (SMEs) can be limited in applying some practices due to limited financial resources and infrastructural facilities (Dangayach and Deshmukh, 2001). Studies addressing lean manufacturing and other best practices have found support for a contingency effect of size (e.g., Cagliano et al. 2001; Shah and Ward, 2003).

A third group of studies has examined the impact of different strategic contexts on manufacturing practices. These works consider that when different strategic goals are pursued, companies may benefit differently from specific practices (e.g., Voss and Blackmon, 1998; Kathuria and Partovi, 1998). Kim and Arnold (1996) show that different areas of investment (i.e. training, integration, information systems, process) are related to different manufacturing objectives (i.e. cost, operations, administration, safety, service, delivery).

Moreover, a specific best practice can impact different performances at the same time and thus, according to the specific strategic goals a company pursues, some best practices may be more beneficial than others. Thus there is some evidence that the strategic context has a significant impact.

The last group of contributions focuses on several other factors that are related to the general context of the organization, such as industry. Industrial sector is another important factor since in different sectors the applicability of specific practices may change and since manufacturing competence may evolve differently in different industries (Kim and Arnold, 1993).

A particular role is played by geographical contingencies. Several contributions have in fact analyzed how practices change among different countries and regions. Womack et al., (1990) studied the application of lean practices in different countries (mainly US and Japan) and highlighted reasons why lean practices couldn't be completely transferred from country to country. Similarly other works have identified that the applicability and application of certain practices may be influenced significantly by the country where the company belongs. Mellor and Hyland (2005) compare improvement programs between OECD and Non-OECD countries and they find that indeed some differences arise between countries in the application of best practices. Similar results can be found in other works (e.g., Buckley and Ghauri, 2004; Prajogo et al., 2007).

Most of the studies reviewed above are static in nature, since they focus on the adoption of best practices in a certain moment in time. However, when taking a dynamic perspective, interesting issues arise about which practices are best practices and why they are adopted. Some authors highlight that best practices evolve over time and eventually new practices become available to companies. For this reason it is important to evaluate the applicability of practices over time by means of longitudinal studies. Limited contributions can be found on this issue and this topic tends to be controversial. Flynn et al. (1999) provide evidence that best practices are stable over time while Laugen et al. (2005) show that some best practices seem to endure over time and others don't. These results are also based on limited comparisons in terms of time span. For this reason some authors argue that there is much need for studies on the evolution of manufacturing strategy over a long period of time (Minor et al., 1994; Voss, 2005).

In addition, a better understating of the dynamic nature of best practice requires also verifying if the conditions for applicability of best practices change over time as in different periods of time the competitive setting in which companies operate is expected to change. For example variations in the business environment (e.g. market, supply chain globalization, information technology, new production technologies) can make more or less effective the adoption of a particular best practice.

Moreover, the change in the emphasis on one manufacturing practice or another might also be related to the evolution of manufacturing capabilities over time. In fact, some literature have highlighted that there are some specific “patterns” that companies follow when they develop their capabilities. Ferdows and De Meyer (1990) have illustrated that competitive capabilities seem to accumulate in a specific order (the so-called “sand cone” effect). Roth (1996) has shown that there is a “competitive progression” by which companies develop their capabilities. Similarly Narasimhan et al. (2005), by introducing the notion of “strategic capability progression”, identify a progression of capabilities linked to specific performance gains.

All these elements raise the hypothesis that best practices may change their role in the strategic plan over time, thus some may become “commodities” while others may allow new practices to be introduced.

3 Research objectives

The goal of this paper is to investigate if and how the relationship between competitive priorities and manufacturing (best) practices changes over time, adopting a longitudinal perspective.

We move from the assumption that manufacturing best practices, often called also manufacturing improvement programs (De Meyer and Ferdows, 1990), are generally adopted in coherence with the company strategy, i.e. the strategic context, in particular to the specific competitive priorities (e.g. Kim and Arnold, 1996; Flynn et al., 1999; Spring, and Boaden, 1997; Dangayach and Deshmuk, 2001) pursued, and other contingent variables.

In fact there is a broad consensus over the contingent nature of manufacturing strategy (Voss, 2005; Voss and Sousa, 2008): both competitive priorities and manufacturing practices depend on several other factors such as company size, industry, national culture, etc.

However, such relationship is often considered as static, i.e. practices are adopted to pursue one or more goals, but these are not considered to change over time. This is often due to the fact that such relationship is generally investigated with panel data, all gathered simultaneously. Therefore it is not clear whether time also plays a role; in other words, it is not clear whether time can be considered as another relevant contingent variable in influencing manufacturing strategy.

We think it is relevant for several different reasons. First of all time can be considered as a proxy of an evolving scenario, which includes phenomena such as globalization, market dynamics, evolution of customer needs, etc. therefore the adoption and drivers can change along the years. Next, company strategic goals can change thus leading to changes in the specific practices adopted. Moreover, different best practices emerged in different moments in time. Take the example of Lean Manufacturing (Womack et al., 1990), Total Quality Management (Powell, 1995), Advanced Manufacturing Technologies (Boyer et al., 1997): each of these "best" practices has generally captured the attention of both researchers and practitioners for its novelty and the considerable benefits expected by its adoption. Subsequently, such practices have become more widespread and have moved from being a novelty to be considered as "the way things should be done" and therefore more of an industry standard than a source of competitive advantage. Finally, there can be a sequential adoption of best practices, as exposed in the competitive progression theory (Roth, 1996).

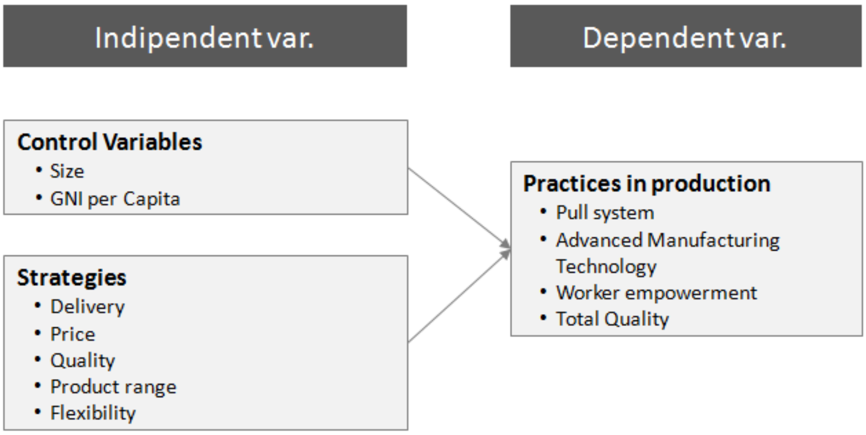
As a consequence, we expect that the relationship between competitive priorities and manufacturing practices evolves over time, and therefore we formulate the following research proposition:

Manufacturing practices are adopted to pursue different sets of competitive priorities in different moment in time.

We aim at testing this proposition and investigating in depth which sets of competitive priorities determine the adoption of manufacturing best practices in different moments in time (Figure 1).

In line with results from previous contributions that have shown that the adoption of best practices is influenced by the size of the company (see e.g. Cagliano et al., 2001) and by the country (see e.g. Womack et al., 1990), the test of the above proposition is performed controlling for the effect of both these variables.

Figure 1 - Research framework



Competitive priorities are measured through the established constructs of price, quality, service, product range and flexibility (e.g. Kim and Arnold, 1996; Flynn et al., 1999; Spring, and Boaden, 1997; Dangayach and Deshmuk, 2001).

In terms of best practices, we will focus on those strictly related to the manufacturing functions, and consequently we will not consider those involving the relationship between manufacturing and other functional areas such as product development, sourcing and distribution. In particular, we will consider: pull systems (e.g. Huson and Nanda, 1995), advanced manufacturing technology (Boyer et al., 1997; Cagliano and Spina, 2000; Kotha and Swamidass, 2000), worker empowerment (e.g. Youndt et al., 1996), total quality (e.g. Samson and Terziovski, 1999).

4 Research Methodology

4.1 Sample

In order to pursue our research goals, we use data collected from the four editions of the International Manufacturing Strategy Survey (IMSS), a research project carried out in 1992, 1996, 2001 and 2005 by a global network. This project originally launched by London Business School and Chalmers University of Technology, studies manufacturing and supply chain strategies within the assembly industry (ISIC 28-35 classification) through a detailed questionnaire administered simultaneously in many countries by local research groups. Responses are gathered in a unique global database (Lindberg *et al.*, 1998). The overall sample consisted of 600 firms from 20 countries in 1992 (average response rate 33%), 701 firms from 23 countries in 1997 (response rate 21%), 558 firms from 17 countries in 2001 (response rate 33%) and 698 firms from 22 countries in 2005 (response rate 22%)[1].

From this database we dropped cases not providing company size. The distribution of the four samples in terms of country, industry and size is shown in Table 1, Table 2 and Table 3.

Table 1 – Country distribution of the four samples

Country	**IMSS Version**				**Country**	**IMSS Version**			
	I	**II**	**III**	**IV**		**I**	**II**	**III**	**IV**
Argentina	40	31	14	44	Israel	0	0	0	20
Australia	26	54	40	14	Italy	40	68	58	45
Austria	25	0	0	0	Japan	23	26	0	0
Belgium	3	0	19	31	Mexico	62	25	0	0
Brazil	25	21	34	13	New Zealand	0	32	0	30
Canada	22	36	0	24	Norway	19	13	35	17
Chile	6	10	0	0	Portugal	41	0	0	10
China	0	16	22	31	Korea, Rep.	0	44	0	0
Croatia	0	0	34	0	Spain	27	32	20	0
Denmark	16	27	38	36	Sweden	59	27	18	82
Estonia	0	0	0	21	The Netherlands	27	27	14	63
Finland	17	14	0	0	Turkey	0	0	0	33
Germany	23	27	31	18	USA	35	33	9	35
Hong Kong	0	10	0	0	United Kingdom	35	24	44	16
Hungary	0	36	58	53	Venezuela	0	0	0	30
Ireland	0	0	32	13	**Total**	**571**	**633**	**520**	**679**

Table 2 – Industry distribution of the four samples (the high number of missing values in IMSS I and II is partly due to a different codification used)

	IMSS Version			
	I	II	III	IV
28	173	197	170	259
29-30	76	92	132	159
31-32	111	148	128	125
33	44	45	41	29
34-35	70	65	43	100
Missing	97	86	6	7
Total	571	633	520	679

Table 3 – Size distribution of the four samples

	IMSS Version			
	I	II	III	IV
Small	198	247	278	395
Medium	152	148	106	133
Large	221	238	136	151
Total	571	633	520	679

Small: less than 250 employees, Medium: 251-500 employees, Large: over 501 employees

[1] Data from Greece have been excluded from the sample due to the very low response rate in this country

The four samples are similar in terms of size, industry and country, however they do not consist of the same firms (only a very limited number of firms participated to two or more editions of the survey).

The operations management literature has seen few contributions that adopt a longitudinal approach. It is no surprise then to discover that longitudinal survey-based methodology is rarely used in operations management research, particularly in the manufacturing strategy field (Dangayach and Deshmukh 2001). This may possibly be a result of the difficulties that emerge when performing longitudinal survey-based studies, especially over long time intervals. First, the same companies have to be considered in the different editions of data collection, yet companies may change over time (e.g., change their business) or disappear (e.g., bankruptcy). Second, managers change inside companies, so their availability to provide information cannot be assured. Lastly, the focus of research should remain stable throughout time, in order to set up a new edition of a survey where almost the same items have been already asked in the past. Because of that longitudinal case studies are more recurrent in this area, as they can overcome many of the described issues. However when doing a longitudinal case study people can be required to answer about past situations with issues related to memory of past events.

Still, longitudinal studies can provide useful and interesting insights into how strategies and practices evolve over time and in relation to the changes in the economic and business context, as strategy and performance topics have a characteristically longitudinal nature (Porter, 1991).

Among the few contributions that succeeded in adopting a survey-based longitudinal or replication approach, we can highlight Frohlich and Dixon (2001), who replicated Miller and Roth (1994) analysis of manufacturing configurations with data from different samples of both the Manufacturing Future survey and the IMSS project. Other examples of longitudinal approach are Kemppainen and Vepsäläinen (2003), who performed a longitudinal research to study trends in industrial supply chains and networks and Giunipero et al. (2005), who analyzed JIT purchasing practices through a longitudinal study. Longitudinal studies have been performed with IMSS data by Cagliano et al. (2005), who studied the shifts in strategic configurations, Cagliano et al. (2008) who studied the trends of globalization of sourcing and sales, and Cagliano et al. (2009) who studied the evolution of the adoption of internet based tools with customers and suppliers.

In this study, we are interested in the general behavior of the sample - i.e. the relationship between competitive priorities and the adoption of best practices. Therefore our model is not pure longitudinal as we are not interested just in those firms that participated to all the four editions, but in the results of the four complete samples (Menard, 1995). The four samples are drawn from the same set of industries and with the same guidelines across the various editions. However, since some differences among the samples exist, in particular in terms of size and country, we will control for such factors.

4.2 Measures

In our analysis we have three types of constructs: competitive priorities, manufacturing practices and control factors. All constructs are measured through the IMSS questionnaire in all four editions.

Competitive priorities are measured in terms of importance of several items to win orders from customers (in line with Hill's order winners). For each item, a Likert-like scale is used, ranging from 1 – not important to 5 – very important. The underlying constructs are those usually considered by many authors (e.g. Kim and Arnold, 1996; Flynn et al., 1999; Spring, and Boaden, 1997; Dangayach and Deshmuk, 2001):

- Price: this is the goal of companies that compete by offering lower selling prices, which generally entail lower manufacturing costs.
- Product range: this competitive priority consists of offering a broader product range, in order to better meet customers' needs.
- Delivery: this construct groups the goals related to product delivery, which includes both speed and dependability.
- Quality: this competitive priority covers manufacturing conformance quality.
- Flexibility: This last competitive priority refers to the ability of providing greater order size flexibility. This construct was not asked in IMSS I, therefore is available only in the last three editions.

The various items are not identical across all four editions, since some refinements have been introduced over time, and some items have been added. However, the five constructs remained the same. All constructs, except for delivery, are single-item, in line with previous research on competitive priorities (see e.g. Frohlich and Dixon, 2001). We performed confirmatory factor analysis on the items referring to Delivery, in order to confirm the validity of the construct. Standardized factor loadings are all significant and with acceptable values, confirming the construct validity. We also measured Cronbach's Alpha to test the reliability of the construct. Values are not very high, however close to the 0.6 threshold (Nunnally, 1978). This is partially due to the fact that Cronbach's Alpha is affected by the number of items in the construct (Table 4). In Table 5 fit indexes for the confirmatory factor analysis of competitive priorities have been reported. Given the high number of single-item factors, models are not so different from a default model in which variables are put together without any underlying structure. Therefore models fit is not always excellent, especially for IMSS I and IV. Nevertheless literature and a specific exploratory factor analysis performed to check the validity of the constructs support this factors structure and allow a longitudinal comparison. Thus we kept our factors as described in Table 4.

Table 4 – Competitive priorities (loadings in brackets, Cronbach's Alpha in bold). For Alphas lower than 0.6 the Pearson Correlation coefficient and significance is reported in brackets)

	I	II	III	IV
Price	–Lower manufacturing costs	–Have lower selling prices	–Have lower selling prices	–Lower selling prices
Product range	–Product range	–Provide a wider product range	–Provide a wider product range	–Wider product range
Delivery	–Faster deliveries (.511) –Dependable deliveries (.659) **α = 0.507** **(corr. 0.339 sig. = 0.000)**	–Offer faster deliveries (.557) –Offer more dependable deliveries (.654) **α = 0.533** **(corr. 0.364 sig. = 0.000)**	–Offer more dependable deliveries (.789) –Offer faster deliveries (.499) **α = 0.561** **(corr. 0.390 sig. = 0.000)**	–More dependable deliveries (.627) –Faster deliveries (.598) **α = 0.541** **(corr. 0.374 sig. = 0.000)**
Quality	–Product design and quality	–Offer superior manufacturing quality	–Offer superior conformance quality	–Superior conformance quality
Flexibility	n.a.	–Provide greater order size flexibility	–Provide greater order size flexibility	–Greater order size flexibility

Table 5 – Fit Indexes for the confirmatory factor analysis of competitive priorities

	Chi-square	df.	p-value	CFI	NFI	RMSEA
IMSS I	23.0	2	0.000	0.852	0.853	0.132
IMSS II	7.6	3	0.056	0.985	0.977	0.047
IMSS III	10.6	3	0.014	0.965	0.955	0.067
IMSS IV	18.5	3	0.000	0.945	0.939	0.086

In appendix (Table 10) the average values of the five competitive priorities in the four samples are shown. We can notice that differences among the samples are quite small, except for Price which drops significantly from IMSS I to the following editions, probably because the phrasing of the question in IMSS I referred to manufacturing costs, rather than selling prices. Within the same sample, instead, some differences can be noticed: quality is always the most important competitive priority, while product variety and flexibility are the least important ones.

In Table 11 (Appendix) the correlation among the competitive priorities in the four samples are shown. It can be noticed that, except for Price, all competitive priorities are generally correlated with each other. This is in line with previous results (see e.g. Cagliano et al., 2005) that showed how companies compete not only on the base of a single competitive priority, but rather pursuing several goals at the same time, generally adopting different combinations of competitive priorities.

Manufacturing best practices are measured through a set of questions about the adoption, in the previous three years, of several manufacturing improvement programs, which refer to well recognized practices. The adoption of each program is measured on a Likert-like scale ranging from 1-No use to 5-High use. In order to focus our analysis, we decided to limit it to practices strictly related to manufacturing, leaving aside those related to the relationship between manufacturing and other functional areas such as new product development, supply and distribution. In particular we focused on the following practices (included in previous contributions such as Flynn et al. 1999):

- Pull system: the restructuring of the manufacturing process and layout to obtain process focus and streamlining (e.g. plant-within-a-plant) and the adoption of pull scheduling (e.g. kanban, smaller batches, reduced setup times, etc.) (Flynn et al., 1999)
- Advanced Manufacturing Technology: engaging in programs aimed at implementing automation technologies in the manufacturing process (e.g. automated parts loading/unloading, automated storage/retrieval systems, automated guided vehicles) and information and communication technologies (Flynn et al., 1999; Boyer et al., 1997). This question was not asked in the first edition (IMSS I), therefore it is available only for the subsequent three editions (IMSS II, III and IV).
- Worker empowerment: implementing actions to increase the level of autonomy and empowerment of the workforce, by adopting autonomous teams and continuous improvement programs (e.g. kaizen). This construct groups two variables measured by Flynn et al. (1999).
- Total quality: programs for quality improvement and control (e.g. Total Quality Management) and for improving equipment productivity (e.g. Total Productive Maintenance), in line with Flynn et al. (1999).

Each practice is measured through at least two items, except in one case (worker empowerment in IMSS III, in which the two items were merged in a single question). Confirmatory factor analysis has been performed, with good and significant loadings.

Also in this case and Cronbach's Alpha has been used to measure reliability, values ranges from a low of 0.553 to a high of 0.817 (Table 6). For the factors with Alpha lower than 0.6 the Pearson correlation has also been computed, in order to further check the reliability of the construct.

In Table 7 fit indexes for the confirmatory factor analysis of manufacturing best practices have been reported. Like competitive priorities, also in this case models do not show always a perfect fit, especially those of IMSS II and III. However fit indexes are quite high and again literature and a specific exploratory factor analysis performed to check the validity of the constructs support this factors structure and allow a longitudinal comparison. Thus we kept our factors as described in Table 6.

Table 6 - Factor analysis for the adoption of manufacturing best practices (loadings in brackets, Cronbach's Alpha in bold). For Alphas lower than 0.6 the Pearson Correlation coefficient and significance is reported in brackets

	IMSS I	IMSS II	IMSS III	IMSS IV
Pull system	– Pull scheduling (Kanban) (.749) – Plant within a plant (.627) **α = 0.628**	– Pull scheduling (Kanban)	– Pull production (e.g. Kanban) (.732) – Manufacturing process focus (e.g. reorganize plant within a plant) (.785) **α = 0.733**	– Pull production (e.g. Kanban) (.687) – Manufacturing process focus (e.g. reorganize plant within a plant) (.701) **α = 0.634**
Advanced Manufacturing Technology		– Automated parts loading/unloading (.665) – AS/RS (.755) – AGV (.710) – CIM (.664) **α = 0.817**	– Process automation programs (.682) – Implementing Information and Communication Technologies and/or ERP (.562) **α = 0.553** **(corr. 0.383 sig. = 0.000)**	– Process automation programs (.667) – Implementing Information and Communication Technologies and/or ERP (.617) **α = 0.584** **(corr. 0.413 sig. = 0.000)**
Worker empowerment	– Implementing team approach (.552) – Kaizen (.750) **α = 0.582** **(corr. 0.414 sig. = 0.000)**	– Kaizen	– Workforce level of delegation and knowledge of (e.g. improvement or autonomous teams)	– Workforce level of delegation and knowledge of (e.g. improvement or autonomous teams) (.589) – Implementing continuous improvement programs (e.g. kaizen) (.726) **α = 0.604**
Total Quality	– TQM (.690) – Statistical Process Control (.495) – Zero defect (.737) – Total productive maintenance (.627) **α = 0.710**	– TQM (.632) – Statistical Process Control (.649) – Total productive maintenance (.663) **α = 0.730**	– Quality improvement and control programs (e.g. TQM programs) (.700) – Equipment productivity (e.g. total productive maintenance programs) (.810) **α = 0.726**	– Quality improvement and control programs (e.g. TQM programs) (.719) – Equipment productivity (e.g. total productive maintenance programs) (.740) **α = 0.699**

Table 7 – Fit Index for the confirmatory factor analysis of manufacturing best practices

	Chi-square	df.	p-value	CFI	NFI	RMSEA
IMSS I	21.3	17	0.213	0.996	0.979	0.021
IMSS II	85.9	23	0.000	0.960	0.947	0.062
IMSS III	25.3	9	0.003	0.985	0.977	0.057
IMSS IV	19.7	14	0.139	0.995	0.985	0.024

In Appendix (Table 12) the average values of the adoption of the four best practices in the four samples are reported. Differences among the four samples are limited also considering the adoption of best practices, and average values are all close to the center of the scale. However some trends emerge from the comparison: Pull system has been growing from IMSS II to IMSS IV, becoming the most adopted practice. Advanced Manufacturing Technology (which is the least adopted practice) has grown from IMSS II to IMSS IIII and then remained stable. On the contrary, Worker empowerment, which has been the most adopted practice for the first three editions, has been decreasing steadily from IMSS I to IMSS IV. Finally, Quality has remained stable across the four editions.

We checked also for Common Method Bias (CMB) that in survey based studies can affect statistical results. First of all we applied Harman's one-factor test by performing a factor analysis on all the items in each edition of the survey (Podsakoff et al., 2003). We reported the number of factors extracted until they have an eigenvalue lower than one, the cumulative variance explained and the variance explained only by the first factor in the unrotated solution. As reported in appendix (Table 13) the number of factors extracted is usually higher than one (three or four) and the variance explained by one single factor is always low (below 30%). We can conclude that in this data selection common method bias is not a cause of concern.

Finally, control factors are measured as follows: size is measured through the actual number of employees of the plant under analysis (IMSS is focused on single plants); GNI per capita is measured through 2005 World Bank data (Atlas Method).

In order to test our research proposition we adopted multivariate linear regression. In this analysis best practices are considered as dependent variables, while control variables and strategic goals are considered as independent. For each practice we applied the following procedure based on each of the four considered samples (i.e., IMSS I, II, III, IV).

1. First we add Size and GNI per capita as control variables
2. Second, we run a stepwise regression on the strategic goals so to select the significant ones in the regression, keeping the control variables in the model.

Each step of the procedure was controlled for multicollinearity by checking the variance inflation factor the regressors' eigenvalues and the related condition indexes[2] . Variance inflation factor is always lower than 1.5 on a cut-off point of between 5 or 10 (Menard, 1995; Neter et al., 1989; Hair et al., 1995) while the condition index is on average below 15 (Belsley et al., 1980). For models between 15 and 20 there is a medium risk of multicollinearity, even values are below 30 that is considered the threshold for a high risk. Moreover given the low variance inflation rate of the variables in theses model, multicollinearity is not considered an

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[2] Condition indexes are computed as the square roots of the ratios of the largest eigenvalue to each subsequent eigenvalue.

issue for any model. R^2 change was also taken into consideration in order to evaluate whether strategic goals really had explanatory power or not: R^2 change was always significant.

5 Results

Table 8 provides details on the statistical results. For briefness sake only variables that were significant in at least one sample were considered. Table 9 reports the R-square for the final models obtained from the step-wise procedure.

Here a discussion of the identified relationships is provided: first control variables are considered and then strategic goals will be analyzed.

Table 8 – Two-step regression analysis results

	I		II		III		IV	
	Coeff.	**Sig.**	**Coeff.**	**Sig.**	**Coeff.**	**Sig.**	**Coeff.**	**Sig.**
Pull system								
Size	0.109	0.034	0.181	0.000	0.163	0.001	0.118	0.003
GNI per capita	-0.194	0.000	0.035	0.424	0.015	0.753	0.063	0.116
Product Range			0.119	0.006			0.158	0.000
Quality							0.080	0.044
Delivery	0.134	0.009						
Worker empowerment								
Size	0.068	0.130	0.178	0.000	0.116	0.017	0.223	0.000
GNI per capita	-0.014	0.763	-0.030	0.486	-0.035	0.478	0.063	0.105
Product Range							0.085	0.028
Quality			0.098	0.022			0.188	0.000
Delivery	0.149	0.001						
Total Quality								
Size	0.093	0.032	0.260	0.000	0.214	0.000	0.174	0.000
GNI per capita	-0.206	0.000	-0.124	0.004	-0.167	0.000	-0.114	0.003
Quality			0.141	0.001	0.138	0.004	0.131	0.001
Price			0.112	0.008				
Flexibility							0.100	0.011
Delivery	0.128	0.003						
Advanced Manufacturing Technology								
Size			0.370	0.000	0.209	0.000	0.231	0.000
GNI per capita			0.010	0.813	0.076	0.120	0.044	0.260
Product Range			0.142	0.001				
Quality			0.111	0.009	0.098	0.049	0.083	0.040
Price							0.086	0.028
Delivery							0.091	0.026

Table 9 - R-square values for the final models

	I	**II**	**III**	**IV**
Pull system	0.068	0.049	0.027	0.045
Worker empowerment	0.028	0.044	0.015	0.100
Total Quality	0.070	0.121	0.115	0.088
Advanced Manufacturing Technology	-	0.182	0.062	0.081

5.1 Control variables

First of all, size seems to play a role in the adoption of all practices especially in more recent times; in fact size is significant with a positive estimate in IMSS II (only in one case), III and IV (in all cases), meaning that larger companies tend to adopt best practices more than smaller firms. This result is not surprising since all these practices require investments that are easier to support in larger companies (e.g. Cagliano et al., 2001). Nevertheless this trend has become stronger overtime as if at the beginning these practices were put in practice either by large or small companies. This can be partially explained considering that larger companies given their inertia can be slower in the adoption and implementation of new practices. Moreover if they have a well running business with solid relationships with customers they could be in past less pushed on improving their operational performances. In fact the first significant effect of size on adoption of practices is observed in IMSS II in the adoption of worker improvement practices that is an “internal” change. Next with the commoditization of markets, customers have turned out to be more and more demanding about high service level and quality pushing leading companies to invest in these areas.

Geographical areas also play a relevant role in determining the extent of adoption of specific practices. However there is no clear trend over time.

Mediterranean countries show a lower adoption of Pull System in IMSS II and III and Total Quality in IMSS II, but higher adoption of Total Quality and Advanced Manufacturing Technology in IMSS IV. One possible reason for this may be the fact that these companies were lagging behind in the 90s and are now trying to catch up with other countries.

North American companies showed a higher adoption of Pull System, Worker Empowerment and Total Quality in IMSS I and II (except for quality); however this difference has disappeared over time.

Asia Pacific companies show a similar pattern as North American ones for IMSS I, while in IMSS II we observe an higher adoption of Worker Empowerment and Advanced Manufacturing Technology, but afterward no impact can be found.

South American companies show lower use of Advanced Manufacturing Technology in IMSS II, but higher investments in the last two editions, in particular on Total Quality. Similarly to Mediterranean companies, South American ones are bridging the gap with the rest of the world.

In the end it is worth to notice that North European companies show only a slightly significant and negative difference in the adoption of Total Quality in IMSS I and II. For the rest they are in line with the average of the sample.

All these results claim that there is to some extent a geographical effect on the adoption of best practices, however these impacts tend to change from edition to edition.

In synthesis we can conclude that geographical areas do have some impact on the adoption of practices, as suggested in previous contributions (e.g. Womack et al., 1990), but such impact is different from practice to practice and also changes over time. This is not the main focus of this paper, rather it is a control variable for our purposes, however these results confirms that the drivers for the adoption of best practices changes over time, also within the same area. This means that there is no stable bias in favor of one or few practice in each area. Very often geographical areas are considered to be strictly related to different cultures, which in turn affect the way work is organized and companies are managed (Hofstede, 1991). Our results confirm this, but also suggest that the relationship between culture and manufacturing practice evolves over time..

Since both size and GNI per capita have a significant impact on the adoption of best practices, we have kept them into our regression model, in order to be able to investigate the differential impact of competitive priorities.

Competitive priorities

When competitive priorities are considered, several results can be identified. Looking broadly to the results we can observe that the linkage between competitive priorities and best practices has changed over time. This confirms our initial research proposition that manufacturing practices are adopted to pursue different sets of competitive priorities in different moment in time. Moreover it is not possible to highlight a clear pattern, but just to interpret some underlying dynamics.

For clarity sake we can summarize the results in two main groups related to the impact of each competitive priority on the various best practices, and the various drivers for each best practice.

5.2 *Impact of competitive priorities*

To better represent the relationship between practices and competitive priorities we drop from Table 8 rows about size and geographical area thus keeping only competitive priorities (Figure 2).

Figure 2 – Extraction of the significant regression coefficients

	IMSS Version			
	I	II	III	IV
Pull System				
Product Range		V		V
Quality				V
Delivery	V			
Worker Empowerment				
Product Range				V
Quality		V		V
Delivery	V			
Total quality				
Quality		V	V	V
Price		V		
Flexibility				V
Delivery	V			
Advanced Manufacturing Technology				
Quality		V	V	V
Price				V
Delivery				V
Product Range		V		

First we can identify that the different competitive priorities do not have the same spread of impact. Let's consider each priority separately:

- Delivery is found significant for all considered practices, although in different moment in time: in IMSS I on Pull System, Worker Empowerment and Total Quality, while in IMSS IV on Advanced Manufacturing Technology. This is partially due to the multidimensionality of delivery, which includes both speed and dependability. In fact companies may try to better serve their customers by having more reactive production systems, thus investing in pull production, or by investing more in worker empowerment which is usually a key asset to avoid delays. Also Total Quality, by reducing scraps and reworks can enable faster and more dependable deliveries. More recently, companies need to cope with higher customization, thus invest in advanced manufacturing systems also to be able to deliver on time.

- Quality shows impacts on all the four practices: obviously Total Quality (IMSS II, III and IV), but also Worker Empowerment (IMSS II and IV), and Advanced Manufacturing Technology (IMSS II, III and IV).
- Product range impacts on three practices: Pull System (IMSS II and IV), Advanced Manufacturing Technology (IMSS II) and Worker Empowerment (IMSS IV). This result can be interpreted as follows: to offer a broader product range in an effective and efficient way, the manufacturing system should be able to work on the base of demand rather than forecast, i.e. in a pull rather than a push system. In the past flexible technology has been considered a key tool to offer a broad product range, but more recently companies realized that a higher autonomy of the workforce is needed to sustain such a competitive priority.
- Price does not occur frequently: it has an impact twice on Total Quality (IMSS I and III) and once on Advanced Manufacturing Technologies (IMSS IV). This is a confirmation that TQM and TPM are adopted not only to improve quality, but also to reduce costs, and therefore to support a low-price strategy. Also technology, in particular in more recent times, is adopted to pursue this goal, by substituting human labor and thus reduce manufacturing costs.
- Finally, Flexibility only occurs once, in particular this priority affects the adoption of Total Quality in IMSS IV. Definitely flexibility is not a frequent driver of the adoption of best practices, probably due to the fact that this is not even considered as one of the most important competitive priority. However it is interesting to notice that, in order to provide greater order size flexibility, companies tend to improve their quality management system, in order to improve both quality and productivity, rather than adopting other practices.

5.3 Drivers of adoption of best practices

Let’s consider now which are the competitive priorities driving the adoption of each best practice:

- Pull System is adopted to pursue delivery goals in IMSS I and offer a broader product range in both IMSS II and IV, while no significant relationship can be detected in IMSS III (although the practice was still adopted to some extent). It is interesting to notice that pull system was adopted originally to improve speed and dependability of deliveries, therefore emphasizing the benefits in terms of planning and smooth flows. Subsequently attention on this practice has declined. But afterwards the focus has shifted towards the ability to offer a broad product range, which determines the need for a pull system, in order to be able to respond to the demand without building up excessive stocks.

- Advanced Manufacturing Technology is adopted responding to different competitive priorities in the three editions where it has been analyzed: to offer a broader product range in IMSS II, to provide better quality in IMSS III, and to provide faster and more dependable deliveries, as well as to offer a lower price, in IMSS IV. This is a case of highly changing drivers, however there are good reasons behind. In the mid nineties flexible technologies were considered the solution to provide the increasingly broader product range requested by customers. In 2001 automation had shown its limit in coping with such variety, and therefore advanced manufacturing technology was adopted more to ensure better product quality, in particular by integrating information and communication technologies into manufacturing. Finally, in 2005 the increase in global competition and the pressure for lower prices and better service levels at the same time, have shifted again the focus, leading to the adoption of technology mostly to reduce manufacturing costs and to increase the speed and the dependability of the process. This is particularly true in areas where labor costs are higher and therefore technology is used instead of manpower, but automation and information technology support delivery goals also where labor costs are lower.
- Worker Empowerment is adopted in 1992 to pursue delivery goals, and in 2005 to provide a broader product range and better quality. At the beginning of the 90s this practice was considered as a way to speed up processes by enabling the workforce to make autonomous decision and to self-coordinate. More recently, this practice has been seen as a way to respond to various goals, in particular the ability to offer a broad product range by leveraging on a more skilled and engaged workforce, and also to improve quality through continuous improvement. In IMSS III instead there is no relationship between any competitive priority and this practice. Since worker empowerment was adopted anyway this means that there were drivers other than competitive priorities that pushed the adoption of this practice. It is not surprising indeed that this happened twice for Worker Empowerment that usually has an indirect secondary and longer term effect on company's performances. Therefore a correlation with competitive priorities can be weaker, as our data show.
- Total Quality, finally, is adopted to respond to more than one strategy, and this happens three times (IMSS I, III and IV). This means that companies may address with the same

practice different strategic objectives and that Total Quality seems particularly versatile. We can interpret this result also in another way. Given the existence of strategic configurations (Miller and Roth, 1994), some companies may adopt more than one competitive objectives at a time. As a consequence we can hypothesize that companies that pursue more than one objective tend to use more Total Quality programs because it is transversal to the organization and able to impact on different areas. Quite interestingly, however, the competitive priorities related to Total Quality change overtime: in IMSS I are Price and Delivery, in IMSS II only Flexibility, in IMSS III Quality and Price, in IMSS IV Quality and Flexibility. This confirms that Total Quality can be used to address different needs according to the specific contingent situation. On the other hand, one may argue that Total Quality has received so much attention in the last decades to be adopted by many firms, also with different competitive priorities, sometimes more because "everybody does it" than for a real strategic intent. This could also partly explain the multiple and continuously changing drivers.

6 Discussion

The results presented so far support our research proposition, since the adoption of manufacturing best practices is actually driven by different sets of competitive priorities in different moments in time. Therefore we have provided a broad empirical evidence to support the position expressed by Voss (2005), who claimed that best practices are contingent in nature and their adoption (and success) depends upon several factors, in particular the strategic context of the firm. Our results have also been controlled for two of the most cited contingent variables (Sousa and Voss, 2008), namely company size and geographical area, which are generally considered as very influential in determining the adoption of best practices. But we have also introduced another contingent variable, i.e. time, which is seldom included in previous research given the difficulties related to longitudinal analysis, despite its broadly recognized relevance.

The analysis of the relationships between competitive priorities and best practices across the four editions of the IMSS project has provided the following main outcomes:

- Competitive priorities do not change very much in terms of their average relevance in the various samples, however their impact on the adoption of best practices changes, suggesting that companies decide to pursue the same goal in different ways in different moment in time. Therefore manufacturing firms on average are not static in their strategic behavior, rather they deploy their competitive priorities by adopting different practices. Besides, some competitive priorities tend to impact on multiple practices at the same time, like Delivery in IMSS I, Quality in both IMSS III and IV, and Product Range in both IMSS II and IV, but this impact is not stable across the various editions. Other priorities, instead, tend to impact on single practices, such as Price and Flexibility in several editions. Of course this is limited by the range of practices included in our analysis, however we have included a reasonably broad spectrum of practices, therefore we can suppose that some priorities tend to have a more focused impact while others tend to have a broader impact on the adoption of best practices. However, behind such results there is also a potential risk: the shift in the relationship between competitive priorities and best practices could be a sign of unclear and uncertain strategy deployment.

- Shifting the focus on best practices, in order to understand which are the drivers that lead to their adoption, we have shown that relationships are very dynamic also from this perspective. In particular, the same best practice is adopted in different moments for different reasons, suggesting that such a practice is expected to provide various benefits, perhaps due to the results achieved by previous adopters and to the better knowledge developed over many years of usage. However, there is also another possible interpretation: best practices may be adopted rather independently from competitive priorities, more as a "fashion" rather than a conscious decision. In any case, we have found some practices that are related to several competitive priorities at the same time. This is particularly true for Total Quality, which is probably the most diffused and renowned practice of the last twenty years, and is generally acknowledged to be instrumental to several goals. The other practices, are generally related to just one priority at a time (with the exception of Advanced Manufacturing Technology and Worker Empowerment in IMSS IV). This is a sign of more focused adoption, however it is relevant to remark that such relationships are not constant across the various editions, therefore results are unstable. Finally, there are some cases of practices without significant relationships with priorities, in particular Pull System in IMSS III and Worker Empowerment in IMSS II and III. We have already anticipated that this can be interpreted as a case of adoption not directly related to a specific strategy, but rather as a source of generic improvement on the long term. Of course there are several other drivers that could affect these practices but have not been considered in our analysis, but there is also the risk of adoption without clear goals, or worse just for sake of imitation of others or imposition by customers.

- Finally, these results pose a new question: are best practices really adopted for strategic reasons, or rather for a set of various reasons that could also be totally different? The multiple and constantly changing relationships between competitive priorities and best practices in our analysis cast some doubts on the strategic intent behind the adoption of best practices. Moreover, the fact that practices widely spread such as Total Quality show so many relationships, while others such as Worker Empowerment show no relationships in some cases, further support this question. Some practices, even if they can still be considered “best” compared to less performing ones, are not really “best” in the sense that they provide significant competitive advantages, but rather are a sort of minimum requirement to stay in business. At the same time, it is important to remark that we have measured the level of adoption of best practices, but not how this has been done, nor the specific outcome of each. Therefore it is likely that some firms have achieved better results compared to other, even if they have adopted the same practice. Over time, this can result in some firms abandoning a practice for another one, in particular for those who had bad results. Firms who achieved good results, instead, are likely to continue adopting such practices, even if their strategic goals have changed.

7 Conclusions

In this paper we have analyzed the relationship between competitive priorities (namely Price, Quality, Delivery, Product Range and Flexibility) and the adoption of best practices (namely Pull Systems, Advanced Manufacturing Technology, Worker Empowerment and Total Quality), across four editions of the International Manufacturing Strategy Survey (from 1992 to 2005) and controlling for both company size and geographical area.

Results have shown that competitive priorities have a significant impact on the adoption of best practices, but such impact is not stable over time, therefore confirming the contingent nature of best practices.

We have demonstrated that the adoption of best practices is influenced by several factors, starting from the well known company size and geographical area (our control variables), moving to the competitive priorities and including also the temporal dimension. Therefore we can conclude that company strategy is a relevant contingent variable that explains the adoption of best practices, as suggested by Voss (2005). Furthermore, also time is a key variable to explain the adoption of best practices; this relationship has been hypothesized by some authors but not proved so far. Therefore, a valuable contribution to research lies also in the longitudinal perspective, which has been seldom adopted so far in manufacturing strategy literature, despite the calls for this kind of analysis. Despite the unavoidable limitations of this analysis (companies are not all the same in the various editions, the participating countries are not always the same, etc.), having controlled for the most critical factors, we have shown that the data obtained in different years lead to very different results, thus confirming the importance of the longitudinal approach.

In terms of managerial implications of our results, we can highlight how best practices can be adopted for several reasons, in particular those who can impact on several performance areas, such as Total Quality, or improve the way the organization works in general, such as Worker Empowerment, despite no immediate impact on final performance can be expected. At the same time, we would like to point out to managers the risk of adopting best practices just for sake of imitation of others or for external pressures. Best practices do not provide benefits automatically, it is not enough to declare that they are adopted nor to copy other organizations. Therefore a clear and conscious decision needs to be taken, aligning best practices to competitive priorities, thus increasing their potential benefits.

Finally, it is important to acknowledge the main limitations of this research, and consequently to indicate interesting future developments. As anticipated, several limitations lie in the longitudinal approach, which is very difficult to put into practice and anyway implies several compromises. Besides, it would be interesting to investigate also the link with performance, in order to understand whether best practices actually lead to best performance, and if they are aligned with the competitive priorities. However, the research model is already quite complex without them, and several existing contributions have already investigated the relationship between best practices and performance. Finally, we have limited the analysis to a subset of industries and to best practices strictly related to the manufacturing function. Clearly the analysis could be extended to other practices and other industrial sectors.

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Appendixes

Table 10 – Average values of the competitive priorities in the four samples

	IMSS I	IMSS II	IMSS III	IMSS IV
Price	4.331	3.760	3.737	3.886
Product range	3.389	3.403	3.324	3.347
Delivery	4.206	4.114	4.040	4.091
Quality	4.596	4.336	4.172	4.197
Flexibility	n.a.	3.355	3.349	3.479

Table 11 – Correlations among the competitive priorities in the four samples

	IMSS Version	Delivery	Price	Quality	Product variety	Flexibility
Delivery	I	1.000	0.116**	0.122**	0.221**	-
	II	1.000	0.131**	0.328**	0.187**	0.306**
	III	1.000	0.072	0.281**	0.089*	0.336**
	IV	1.000	0.124**	0.244**	0.177**	0.346**
Price	I	0.116**	1.000	0.020	-0.007	-
	II	0.131**	1.000	-0.015	0.004	0.091*
	III	0.072	1.000	0.011	-0.049	0.070
	IV	0.124**	1.000	-0.018	0.018	0.117**
Quality	I	0.122**	0.020	1.000	0.184**	-
	II	0.328**	-0.015	1.000	0.108**	0.175**
	III	0.281**	0.011	1.000	0.144**	0.172**
	IV	0.244**	-0.018	1.000	0.047	0.163**
Product range	I	0.221**	-0.007	0.184**	1.000	-
	II	0.187**	0.004	0.108**	1.000	0.233**
	III	0.089*	-0.049	0.144**	1.000	0.204**
	IV	0.177**	0.018	0.047	1.000	0.156**
Flexibility	I	-	-	-	-	-
	II	0.306**	0.091*	0.175**	0.233**	1.000
	III	0.336**	0.070	0.172**	0.204**	1.000
	IV	0.346**	0.117**	0.163**	0.156**	1.000

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 12 – Average values of the adoption of the best practices in the four samples

	IMSS I	IMSS II	IMSS III	IMSS IV
Pull system	2.684	2.497	2.923	3.103
Worker empowerment	3.228	3.120	2.984	2.912
Total Quality	2.864	2.949	2.957	2.973
Advanced Manufacturing Technology	n.a.	2.143	2.841	2.846

Table 13 - Harman's one-factor test by factor

	Number of items	Number of factors (with eigenvalue higher than 1)	Cumulative Variance	One factor explained variance
IMSS I	13	4	56.2%	29.6%
IMSS II	15	4	54.0%	27.1%
IMSS III	13	3	49.9%	27.6%
IMSS IV	14	4	54.3%	26.1%