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# Structural and Infrastructural Practices as Elements of Content Operations Strategy. The Effect on Firm Competitiveness

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## Structural and infrastructural practices as elements of content operations strategy. The effect on firm competitiveness

### Abstract

Some extant theoretical studies and different empirical results have demonstrated that firms' behaviour explains several notable competitiveness microeconomic foundations, based on a wide bundle of elements. Firms can directly control most of these elements; in this paper, we will focus on those related to operations management. So, products, processes, technology, equipments or quality control systems will centre our attention. These ones and some additional elements constitute decisions within operations management area that must be included in the *content* of operations strategy. Operations strategy can be conceptualized as a set of decisions or practices with regard to structure and infrastructure variables. On the one hand, these strategic decisions influence firm's abilities to successfully reach some competitive priorities such as, cost, quality, delivery, and flexibility, and, on the other hand, to obtain the expected performance. This research analyses which are the main structural and infrastructural practices that constitute operations strategies in manufacturing companies, and test the effect of these decisions on some firm competitiveness indicators.

*Keywords:* Operations strategy, Manufacturing practices, Competitiveness, Productivity

### 1. Introduction

In current contexts, firms' behaviour establishes some of the most important microeconomic foundations for their competitiveness, based on a wide bundle of elements, as markets or operations and delivery systems, among others (Bradford, 1994). The notable complexity degree of all these factors forces firms to define and

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4 develop some innovative strategies, if they want to sustain their successful competitive  
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6 position.  
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9 Most of these elements can directly be controlled by firms; in this paper we will focus  
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11 on those related to operations management. So, products, processes, technology,  
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13 equipments or quality control systems will centre our attention. Following previous  
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15 literature, we can derive that all of them can influence firms' competitiveness ('e.g.'  
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17 profitability or productivity). In this new competitive landscape, value creation demands  
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19 a complete redefinition of many traditional operations systems and strategies.  
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23 Taking into account all these arguments, we state that operations management can  
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25 meaningfully contribute to better results (Skinner, 1969; Buffa, 1984; Swamidass, 1986;  
26  
27 Hayes *et al.*, 1988; Hill, 1989). In this situation, the explicit definition of manufacturing  
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29 objectives as well as the development and implementation of different specific policies  
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31 and practices, oriented to successfully achieve these objectives, will be necessary. This  
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33 issue has been supported by several authors, as Hayes & Schemenner (1978), Fine &  
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35 Hax (1985), Schroeder *et al.* (1986), Cleveland *et al.* (1989), Roth (1989); Leong *et al.*  
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37 (1990), Boyer (1998), Marucheck *et al.* (1990).  
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41 Operations management can be considered as an operational instrument to gain those  
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43 competitive advantages defined at strategic business unit level (Hayes & Wheelwright,  
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45 1984; Corbett & Van Wassenhove, 1993). Therefore, operations management must be  
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47 integrated into the entire firm strategic process. Then, operations strategy and  
48  
49 competitive strategy must be congruent and strongly linked (Anderson *et al.*, 1989;  
50  
51 Wheelwright & Hayes, 1985; Wheelwright, 1984).  
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55 Within the strategic management literature, a growing stream of thought argues that  
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57 firms' resources and capabilities (Prahalad & Hamel, 1990; Teece & Pisano, 1994)  
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4 explain the most important performance differences. Integrating operations management  
5 within the strategic process, we support that firms' success depends on the efficient  
6 exploitation of manufacturing resources and capabilities, by the *manufacturing best*  
7 *practices* (Hayes & Wheelwright, 1984; Schonberger, 1986; Giffi *et al.*, 1990).  
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12 The arguments presented here are directly based on the three operations strategy  
13 paradigms proposed by Voss (1995). From his point of view, none of them can solely  
14 explain an effective development of operations strategy; nevertheless, their joint  
15 treatment contains all the necessary elements to do that.  
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18  
19 One of these elements is manufacturing practices. Within the definition of the  
20 operations strategy, content and context aspects must be explicitly considered. Content  
21 dimension includes strategic decisions in structure (technology process, plant capacity  
22 and location, vertical integration degree) and in infrastructure (quality management  
23 systems, planning and control systems, inventory management, work force or  
24 organisational design) that influences firms' abilities to successfully obtain their  
25 competitive priorities (cost, quality, flexibility, delivery and service). From the  
26 operations strategy concept, these decisions must capture competitive priorities defined  
27 at strategic business unit level.  
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45 There is a growing interest in the study of the relationship between operations strategy  
46 and competitive advantage –most literature focuses on the relationship between  
47 competitive priorities and performance- (Cleveland *et al.*, 1989; Vickery, 1991; Kim &  
48 Arnold, 1992; Safizadeh *et al.*, 2000). By contrast, the effect of structural and  
49 infrastructural decisions of operations strategy on performance has received less  
50 attention (Swink *et al.*, 2005; Narasimhan *et al.*, 2005). To surpass this shortcoming we  
51 develop the present paper.  
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5 Based on all these arguments, in this paper we analyze two complementary issues: a)  
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7 which are the main decisions and practices that constitute operations strategies in  
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9 manufacturing companies, and b) their effect on firms' competitiveness, in terms of  
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11 productivity. The previously mentioned decisions are proposed to be multi-dimensional  
12  
13 concepts. We expect that current research will help researchers to better understand the  
14  
15 scope of policies and practices associated with operations strategy. Furthermore, we  
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17 offer a validated instrument to measure the structural and infrastructural decisions, and  
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19 provide some additional empirical evidence concerning the effect of these decisions on  
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21 companies' competitiveness.  
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26 The rest of the paper is organized as follows. Firstly, we develop a complete theoretical  
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28 framework about the practices to be included within operations strategy; the treatment  
29  
30 of each one includes a complete definition as well as the necessary arguments to justify  
31  
32 its relevance for firms. Secondly, we offer some operational measures for the included  
33  
34 constructs. To identify different kinds of structural and infrastructural decisions taken  
35  
36 by Spanish manufacturing firms, we develop an exploratory factor analysis; in addition,  
37  
38 to analyse the relationship between these structural and infrastructural operations  
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40 decisions and firms' competitiveness we use a regression equation model. Finally, some  
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42 conclusions and implications for future research are presented too.  
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## 49 **2. Theoretical background**

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51 Voss (1995) identifies three 'paradigms' or theoretical frameworks dealing with  
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53 decisions and content operations strategy, taking into account the reference to the  
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55 Skinner's seminal work (1969). The first one considers operations as an instrument to  
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57 compete in markets, the second one is focused on both internal and external operational  
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4 consistency and, the third one focuses on the positive effect of 'best practices' on firm's  
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6 operations behaviour.

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9 The first framework is the simplest one, as it considers manufacturing as a mere  
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11 competitive function. In other words, any firm may have or control different operations  
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13 capabilities that can be used as strategic assets that must be defined in coherence with  
14  
15 success key market factors, global and marketing strategies as well as market demand  
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17  
18 (Skinner, 1969, 1985; Wheelwright & Hayes, 1985; Slack & Lewis, 2002).

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21 Nevertheless, several papers dealing with manufacturing activities have considered that  
22  
23 operations decisions should actively influence global strategy and not only react to it  
24  
25 (Hayes & Wheelwright, 1984; Buffa, 1984; Hill, 1989). In the same stream of thought,  
26  
27 Platts & Gregory (1992) supported the relevance of operations strategy and evaluated it  
28  
29 in terms of firms' objectives; from this argument, they considered that firm capabilities  
30  
31 are the base for developing innovative operations strategies.

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34 In addition, other models define and propose measures for operations capabilities. In  
35  
36 this sense, Noble (1995) suggests that operations capabilities must be developed  
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38 consecutively in a path-dependent sense, in order to be mutually reinforced. His  
39  
40 findings show that more competitive plants are those that compete on the basis of their  
41  
42 non-imitable and non-substitutable operations capabilities.

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45 The identification of some internal success key factors related to operations  
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47 management has been another research area that has received great attention the in  
48  
49 literature. A notable contribution is Hill's proposal, who argues that markets where  
50  
51 firms act must be analyzed in terms of those criteria that could explain a competitive  
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53 advantage position, as price, delivery, quality, product design, and product variety  
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58 (Miller & Roth, 1994; Platts & Gregory, 1992).

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4 The Voss' (1995) second paradigm is the one related to manufacturing decisions  
5  
6 considering content operations strategy from an integral consistency –internal: among  
7  
8 all manufacturing decisions, capabilities and competitive priorities; and external: among  
9  
10 all manufacturing decisions, and competitive strategy– point of view. Skinner (1969)  
11  
12 identified that key content operations decision areas were those related to layout and  
13  
14 equipment design, production planning and control systems, work force, product design  
15  
16 and organisation. Hayes & Wheelwright (1984) introduced new elements, but Hill  
17  
18 (1993) focused only on two operations decisions: process and operations infrastructures,  
19  
20 or in other words, structural and infrastructural operations decisions, as Heineke stated  
21  
22 (1995: 257). Such decisions were studied from a contingent approach, as they are  
23  
24 influenced by the context in which firm develop their production activities as well as the  
25  
26 competitive strategy (Acur *et al.*, 2003).  
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33 The third theoretical framework refers to implementing operations 'best practices', as  
34  
35 their continuous development moves firms to gain an advantageous position. Best  
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37 practices refers to several techniques, as material planning requirement (MRP), Flexible  
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39 Manufacturing Systems (FMS), Just in Time production (JIT), lean production, Total  
40  
41 Quality Management (TQM), concurrent engineering, and the like.  
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44 From implementing these operations best practices emerges a sort of production  
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46 systems, named 'World Class Manufacturing', (Hayes y Wheelwright, 1984;  
47  
48 Schonberger 1986). This concept was introduced by Hayes y Wheelwright (1984) to  
49  
50 describe those capabilities developed by Japanese and Germany firms to compete in  
51  
52 foreign markets.  
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55 From this perspective, Voss' three paradigms are related to the content of operations  
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57 strategy. But none of them can explain an effective development of operations strategy  
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4 solely; nevertheless, their joint treatment contains all the necessary elements to do that.  
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6 The research agenda presented in this paper will cover these three paradigms with  
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8 particular emphasis on the strategic decisions or practices linked to the content of  
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10 operations strategy approach, considering which these decisions are and how they affect  
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12 organisation competitiveness.  
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### 15 16 17 18 19 **2.1. Defining operations practices**

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21 Firms' competitive priorities and different areas of decision delimit the content of  
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23 operations strategy. Both concepts are strongly interrelated as operations decisions and  
24  
25 competitive priorities must be congruent. The fit between these variables and the  
26  
27 necessary investments in operations structure and infrastructure, may justify the role of  
28  
29 operations area as a source of sustainable competitive advantage, as it is showed in  
30  
31 Anderson *et al.* (1989), Buffa (1984); Cohen & Lee (1985), Hayes & Schmenner  
32  
33 (1978), Hayes & Wheelwright (1984), Roth (1989), Schroeder *et al.* (1986), Skinner  
34  
35 (1969), Stobaugh & Telesio (1983), Swamidass & Newell (1987), Voss (1995), Acur *et*  
36  
37 *al.* (2003).  
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41  
42 There is no consensus among scholars about how to establish the areas of decisions that  
43  
44 must be included in the operations function. Following Schroeder (1981), these areas  
45  
46 influence the way competitive priorities will be reached. Some authors directly identify  
47  
48 operations decisions with firm strategy (Hayes y Wheelwright, 1984) or with operations  
49  
50 objectives (Swamidass y Newell, 1987). If we integrate the arguments presented up to  
51  
52 here, we can define them as the bundle of practices that constitutes the entire operations  
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54 strategy and contributes to get operations competitive priorities and general firm's  
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56 objectives. Therefore, firms are only well positioned when competitive priorities are  
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4 strongly supported by operations decisions (Hill, 1993; Kim & Arnold, 1996; Boyer &  
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7 McDermott, 1999; Smith & Reece, 1999; Acur *et al.*, 2003; Christiansen, *et al.*, 2003;  
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9  
10 Swink *et al.*, 2005).

11 There are several studies trying to delimit and establish which areas of operations  
12  
13 strategy decisions should be included (table 1). The conceptual framework can be  
14  
15 organised around two general categories: structural decisions and infrastructural ones.  
16  
17 This distinction was initially proposed by Hayes & Wheelwright (1984), and supported  
18  
19 by some others some years later ('e.g.' Hayes *et al.*; 1988, Hill, 1993; Heineke, 1995).

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22  
23 [Insert table 1 about here]

24  
25 Almost all structural decisions have several remarkable strategic implications, they  
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27 require substantial financial investments, and have great effects on physical assets. They  
28  
29 have long-term impact and they are not easily reversible, once they have been taken.

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33 Decisions that are more common are those related to some structural practices:

- 34  
35 - *Manufacturing process technology.* Regarding to this variable, firms may  
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37 produce either high volumes of homogeneous and undifferentiated products, or  
38  
39 low volumes of differentiated ones, specific to customers' preferences by using  
40  
41 general equipment or manufacturing machines (Hayes & Wheelwright, 1984).  
42  
43 Innovative information technologies let firms develop and exploit new  
44  
45 automation manufacturing technologies that give these firms with more flexible  
46  
47 and efficient solutions for material requirement planning or operations  
48  
49 engineering (Meredith, 1987; Boyer *et al.*, 1996; Narasimhan *et al.*, 2005).  
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53 - *Vertical integration degree.* Managers have to decide which raw materials or  
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55 components are necessary to be internally developed and which ones must be  
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57 externally bought. Many firms consider that vertical integration is a useful  
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4 choice to get economies of scale. Nevertheless, only those activities that are core  
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6 are included in the value chain of firms (Ferdows *et al.* 1986; Ward *et al.* 1988;  
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8 Kim & Arnold, 1996). In this sense, practices such as supplier partnering, joint  
9  
10 programs with suppliers, and integration of information systems with suppliers  
11  
12 are very important (Narasimhan *et al.*, 2005).  
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- 15  
16 - *Facilities: size, capacity and location.* Facilities operations decisions refer to  
17  
18 size, capacity and plant location. With respect to factory size, managers may  
19  
20 prefer large facilities or, by contrast, small ones. Large size plants may let firms  
21  
22 to get a great amount of low-cost components and products, in addition to  
23  
24 economies of scale. On the contrary, small plants are more appropriate to  
25  
26 flexible organisations. The adoption innovative manufacturing information  
27  
28 technology may get both manufacturing competitive priorities consecutively:  
29  
30 cost and flexibility. Then, taking into account operations objectives and firm  
31  
32 global objectives, production managers must decide which plant size will be  
33  
34 more adequate (Ward *et al.* 1988; Roth & Miller, 1990).  
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37  
38 Factory capacity refers to the level and variety of manufacturing output.  
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40 Managers must decide if they prefer a great variety of products for different  
41  
42 segments or, by contrast, a great level of homogeneous products for only a few  
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44 segments (Ward *et al.*, 1988; Horte *et al.*, 1991; De Meyer, 1992).  
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49 Finally, plant location is of great interest to operations managers; firm may  
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51 prefer to increase either their existent plants or to build other new ones in  
52  
53 different places. Location may depend on a great amount of factors as location of  
54  
55 raw materials, location of markets, availability of transportation and  
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57 communication systems, qualification of work force, and the like. Nowadays,  
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4 globalization is affecting firms' location decisions, as they must be competitive  
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6 within a unique market (De Meyer, 1992; Kim & Arnold, 1996).  
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9 With respect to the infrastructural decisions or practices, we can derive that they have  
10  
11 operatives effects on current costs and have short run effects on firm performance  
12  
13 because do not require large capital investments. They comprise just operational  
14  
15 practices and decisions that correspond to operations managers exclusively. These  
16  
17 decisions may become considered as strategic or tactic choices because refer to the  
18  
19 systems, policies, practices, procedures and organisation which support the  
20  
21 manufacturing processes and enable them to perform their function. Their accumulative  
22  
23 influences can be as difficult and costly to change, as the structural ones are  
24  
25 (Wheelwright, 1984). Among infrastructure, decisions or practices we remark the  
26  
27 following ones:  
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33 - *Production and inventory planning and control systems.* Within this concept are  
34  
35 included two main decisions. Firstly, to evaluate either centralization or  
36  
37 decentralization to middle managers are preferred decision systems; secondly, to  
38  
39 elect between two alternatives operations options: the push system and the pull  
40  
41 one. On the one hand, push system, as Material Requirement Planning, takes as  
42  
43 basic reference expected sales. On the other hand, pull system, as *Just in Time*,  
44  
45 uses real demand; in other words, nothing is produced if it is no demanded. This  
46  
47 implies that planning is short-run developed, reducing inventories of raw  
48  
49 materials, developing products, and final products (Ferdows *et al.*, 1996; Tunälv,  
50  
51 1992; Narasimhan *et al.*, 2005).  
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55 - *Organisational structure and design.* Authority and responsibility systems  
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57 embedded in organisational structure are essential to successfully support the  
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4 remaining operations decisions. Organisational structures can be based on either  
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6 normalisation or autonomy. Normalised structures are those integrated by non-  
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8 autonomous employees that strictly follow rules and procedures previously  
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10 established. This kind of organisations presents a great amount of hierarchical  
11  
12 levels, considering operations systems as a mere cost centre based on formal  
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14 authority. On the contrary, the organic structures are those where experienced  
15  
16 employees can take their own decisions to solve different operations  
17  
18 contingencies. This second point of view considers plants as a profit centre  
19  
20 (Boyer, 1998; Horte et al. 1991; Boyer & McDermott, 1999).  
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- 25  
26 - *Work force management*. Comprises several areas as recruitment, selection, and  
27  
28 formation processes, person to job assignation, pay systems and incentive  
29  
30 policies or job analysis processes, among others. The most important challenge  
31  
32 rests on the definition of that human resource policy that aligns firm objectives  
33  
34 and employees' expectations (De Meyer, 1992; Ward et al. 1994; Boyer, 1998).  
35  
36  
37 - *Quality management*. This variable can be defined from two alternative points of  
38  
39 view. On the one had, quality management can be defined a simple quality  
40  
41 control process oriented to reduce the number of defect final products.  
42  
43 Therefore, it is just an inspection process and quality managers have a minor  
44  
45 responsibility. On the other hand, quality management can be considered as an  
46  
47 entire operations philosophy trying to erode any source of defects. From this  
48  
49 second perspective, it is remarked the role of continuous improvement in cost  
50  
51 reducing and productivity (Ward et al. 1988; Horte et al. 1991; Kim & Arnold,  
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53 1996).  
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Nowadays, the growing interest in environmental protection implies the adoption of some practices and operations decisions as the development of some environmental management systems or the ISO 14001 certification (Gupta, 1995; Shrivastava, 1995).

In short, managers have to take all these decisions with respect to the previously mentioned categories of variables. Furthermore, there are many different choices for any manufacturing decision that can strongly influence firm and competitive strategy of firms (Wheelwright, 1984).

Summing up, in Table 2 we present the measures of structural and infrastructural operations decisions that has been used as reference for our empirical study. Our proposal derived from previous relevant theoretical and empirical papers dealing with this field.

[Insert Table 2 about here]

### 3. Empirical analysis

#### 3.1. Sources of information

Having reviewed the theoretical bases of the manufacturing practices and decisions as elements of content operations strategy, the objectives pursued and methodology used in this work based on the main Spanish industrial companies are reported as follows.

We built our own database for the empirical study, using information contained in the database of 50,000 Main Spanish Companies, edited by Dun and Bradstreet (2002 edition). Specifically, we took a sample of firms, guided by the following two criteria:

a) Industrial firms included (according to the Spanish industry classification system, CNAE) in the groups DJ (Metallurgy & Manufacture of Metallic Products), DK

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4 (Manufacture of Machinery and Mechanical Equipment), DL (Electrical, Electronic and  
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6 Optical Materials and Equipment), and DM (Manufacture of Transport Materials).

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9 b) Firms with more than 50 employees.

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11 The total number of firms contained in the Dun and Bradstreet database complying with  
12  
13 the previous criteria, and consequently participating in the study, was 1820 companies.

14  
15 The unit of analysis used was the production unit or manufacturing business unit (Roth  
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17 & Miller, 1990; Kim & Arnold, 1992, 1996; Tunälv, 1992; Avella *et al.*, 1999;  
18  
19 Kathuria, 2000). The manufacturing unit corresponds to a firm (for medium-sized  
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21 firms), department, division, plant or factory (in the case of large firms), each one of  
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23 which has its own manufacturing strategy, for which the operations managers will adopt  
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25 different structural and infrastructural decisions.  
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### 33 **3.2. Data gathering**

34 As primary source of information, we used a questionnaire that we sent by post to each  
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36 firm's operations manager from the selected sample (in absence of such manager we  
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38 sent de questionnaire to the CEO). Before sending the definitive version, we carried out  
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40 a pre-test to control its validity. This involved personal interviews with both academics  
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42 and operations management specialists from five companies from the sample.  
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46 The definitive questionnaire comprises a series of questions designed, on the one hand,  
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48 to collect basic data about the respondent, their firm, and the type of activity, product  
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50 and production process, and, on the other hand, to evaluate the decisions related to  
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52 manufacturing structure and infrastructure. The questionnaire did not include any  
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54 questions asking for numerical data concerning the results, sales turnover, total assets<sup>1</sup>,  
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<sup>1</sup> We used secondary sources of information to obtain these data, such as the database of 50,000 Main Spanish Companies (from Dun and Bradstreet), and the DICODI directory of Spanish companies.

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4 or similar. This was to facilitate response and avoid a negative predisposition on the part  
5  
6 of the respondents.  
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8  
9 The total number of valid questionnaires received during the period of data collection  
10  
11 was 353, what means a response rate about the 19.53%.  
12

### 13 14 15 16 **3.3. Measures of variables** 17

18 To operationalize all the manufacturing policies and practices several items were  
19 defined, as can be seen in Table 3. We have considered 34 possible manufacturing  
20 practices, which fit into at least one kind of manufacturing decisions identified in the  
21 literature.  
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27 Exactly these scales are strongly supported in previous operations empirical research.  
28 They are similar to those included in the International Survey on the Manufacturing  
29 Strategies of the Large Manufacturing Companies, carried out annually since 1983 as a  
30 base for the research project entitled 'Global Manufacturing Futures Survey Project',  
31 and used by many others authors some years later (Avella *et al.*, 1999; Boyer &  
32 McDermott, 1999; De Meyer, 1992; Ferdows *et al.*, 1986; Horte *et al.*, 1991; Kim &  
33 Arnold, 1996; Miller & Roth, 1994; Roth & Miller, 1990; Tunälv, 1992; Ward *et al.*,  
34 1988).  
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46 [Insert table 3 about here]  
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49 For each item respondents must evaluate –in a seven point scale, where one means very  
50 low, and seven very high– their relative financial investment effort.  
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### 3.4. Analysis of data

In reference to the content validity of measures, the process of elaborating and refining the questionnaire mentioned above ensures it. Moreover, the set of items representing each decision in operations was obtained after reviewing the theoretical and empirical antecedents in the specialised literature. The construct validity was evaluated from a convergent point of view, since we have used multi-dimensional scales to obtain a measure of each structural and infrastructural decision. Thus, we calculated the correlation between each item, achieving very high and significant mean correlations at a confidence level of 99%. The exploratory factor analysis confirmed the unidimensionality of the scales, with the 34 items being represented in seven decisions, high factor loadings and high percentage of variance explained (59.8%).

Secondly, in order to determine the internal consistency of the measuring instrument used, we conducted a reliability analysis by the Cronbach alpha coefficient. The values obtained were superior to 0.7 in almost all cases, which means that we can be confident about the scales employed to measure each of the structural and infrastructural decisions.

Thirdly, we needed to test the representativeness of the firms for which we had information, 'i.e.' those that filled in the questionnaire correctly (353) out of the total sample (1820). This would decide if the results obtained would be generalisable (with caution) to all the organisations from the target population.

For this purpose, we analysed the proportion of firms in each main activity for both the total number of firms making up the initial sample and for the firms correctly completing the questionnaire (Table 4). We can see that the proportion and importance of each industry is maintained, since the percentages corresponding to the groupings by

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4 activities of the firms for which we have information (the questionnaire respondents) are  
5  
6 very similar to those of the population of reference. Thus, after a first approximation,  
7  
8 we can accept that the firms that have been included in the study accurately represent all  
9  
10 the firms in the initial sample.  
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13  
14 [Insert Table 4 about here]  
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16  
17 However, to support the previous claim, we also carried out a difference-of-means test  
18  
19 comparing the industry profiles. The aim was to discover if the firms included in the  
20  
21 study were different from those not included. Table 5 summarises the results of this test.  
22  
23

24 [Insert Table 5 about here]  
25

26 As we can see from this table, the difference of means between the sectorial grouping of  
27  
28 the firms making up the total sample and that of the firms included in the study is  
29  
30 significant at the 5% level, and the confidence interval for that difference contains the  
31  
32 value zero. In other words, we can conclude that there are no differences between the  
33  
34 firms that responded to the questionnaire and those that did not, since the relative  
35  
36 weight of each industrial sector (‘i.e.’ the number of firms belonging to it) is  
37  
38 maintained. This means we can reject the existence of systematic bias in terms of  
39  
40 industry, which confirms what we found in the first analysis.  
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### 47 **3.5. Results**

48  
49 In order to establish main operations decisions taken by Spanish manufacturing firms  
50  
51 were obtained mean and standard deviation descriptive statistics (Table 6).  
52  
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54 [Insert table 6 about here]  
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56 Some interesting conclusions can be obtained from a detailed analysis of these  
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58 preliminary results. From the structural point of view, size and plant capacity are the  
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4 most important variables for the studied firms; in addition, those decisions dealing with  
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6 process, technology and environment protection are relevant too. Alternatively, from the  
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8 infrastructural point of view, the most important manufacturing decisions are those  
9  
10 related to quality management practices, work force, and manufacturing planning and  
11  
12 control systems.  
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16 Additionally, it was undertaken a factorial analysis, in order to test if individual  
17  
18 decisions can be grouped around some representative factors, and, then, to analyse their  
19  
20 relative relevance derived from their factorial charges ( $\lambda_i$ ); results are presented in Table  
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26 [Insert table 7 about here]  
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28  
29 Seven factors were identified, explaining the 59.8% of the total variance. The factorial  
30  
31 analysis confirmed the adequate election of the items previously selected to elaborate  
32  
33 the most representative manufacturing constructs. For the analysed firms, and in this  
34  
35 order, work force and organisation, quality, plant capacity, operations planning, process,  
36  
37 environmental management systems, and vertical integration were the most important  
38  
39 decisions with respect to operations or manufacturing systems. These results show the  
40  
41 greater relevance of short-term infrastructural decisions than those dealing with  
42  
43 structural elements, characterized by higher financial efforts and their irreversible  
44  
45 character. To some extent, an additional analysis of those competitive priorities defined  
46  
47 by these companies should indicate that a notable congruence among them and the  
48  
49 adopted operations decisions must exist (Díaz-Garrido, 2003).  
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54 To analyse the effect of these operations decisions in firm competitiveness, we  
55  
56 developed a regression analysis where dependent variable were firm productivity and  
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4 factors previously identified were the independent ones. The results can be seen in  
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6  
7 Table 8.

8  
9 [Insert table 8 about here]

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11 In the analysis carried out, the assumptions of normality of the distribution of the error  
12  
13 terms, as well as the normality of the individual variables, are fulfilled.

14  
15 The coefficient of determination is 26.5 %. From the empirical results observed, we can  
16  
17 infer that only three independent variables –operations decisions factors– have  
18  
19 significant effect on firm productivity: work force and organisation, process technology  
20  
21 and environment protection. The existence of many other non-operations variables  
22  
23 influencing the relationship between operations decisions or manufacturing capabilities  
24  
25 and firm performance may explain these results, that other studies had previously  
26  
27 obtained too (Boyer y McDermott, 1999; Díaz-Garrido 2003; Heineke, 1995; Kim &  
28  
29 Arnold, 1996; Mills *et al.*, 1995; Safizadeh *et al.*, 2000; Smith & Reece, 1999).

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35 We can conclude the relative importance of some aspects dealing with human resource  
36  
37 management. Some researchers have previously highlighted the importance of some  
38  
39 infrastructural elements related to work force development practices in Spanish  
40  
41 industrial firms (Avella *et al.*, 1999). Then, although companies have focused their  
42  
43 attention on structural decisions, nowadays the importance of infrastructural decisions is  
44  
45 recognised too. Hence, for example, a large number of companies have been capable of  
46  
47 developing a powerful competitive advantage based on their employees' abilities, even  
48  
49 without having exceptional plants and equipments (see Avella *et al.*, 1999; Hayes &  
50  
51 Wheelwright, 1988).

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54 In short, our results suggest that work force development practices are directly related to  
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57 firm productivity. Moreover, our results indicate that practices with regards to process  
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4 technology and environment protection are likely to be important drivers to improve  
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6 performance in today's manufacturing environment too.  
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#### 10 11 **4. Conclusions and future research** 12

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14 Several elements controlled by firms can notably influence their competitiveness. In this  
15  
16 paper, we paid special attention to those related to manufacturing decisions. From  
17  
18 previous proposals, we can infer that operations strategy can contribute to better results.  
19  
20 To create wealth from the operations area, it is necessary to define properly the most  
21  
22 relevant operations competitive priorities and implement some value-creating operations  
23  
24 strategies, practices or decisions. In short, both competitive priorities and operations  
25  
26 decisions establish the content of the operations strategy.  
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30  
31 Although literature has traditionally analysed the relationship between competitive  
32  
33 priorities and competitive strategies, operations strategies, at functional level has been  
34  
35 isolated. Because of that, our research agenda is focused on those decisions that must be  
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37 included in the operations strategy and their effect on firm competitiveness, in terms of  
38  
39 its productivity.  
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42  
43 Previous literature review let us elaborate a theoretical framework for the analysis of  
44  
45 manufacturing decisions. Taking into account the extant research, we can distinguish  
46  
47 between structural (plant capacity and localization, production process technology, and  
48  
49 vertical integration) and infrastructural (quality control and work force, operations  
50  
51 planning and control and organisation) manufacturing decisions. Furthermore,  
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53 nowadays we can add one relevant question: environmental management systems.  
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57 In this paper we have tried to offer some empirical evidence on the current situation of  
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59 industrial firms with regards the development of operations decisions that allow firms to  
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4 achieve sustainable competitive advantages. From a sample of 353 manufacturing  
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6 Spanish firms, we, firstly, have analysed the relative importance of operations decisions  
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8 to the Spanish manufacturing firms studied here. Following mean scores, we can  
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10 conclude that some structural and infrastructural decisions are complementary and  
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12 relevant; the most important ones are plant capacity, quality control systems, work force  
13  
14 and operations planning.  
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17  
18 Secondly, the factorial analysis developed here showed the properly definition of the  
19  
20 items included in the survey concerning manufacturing decisions. Summing up, seven  
21  
22 factors or operations decision areas were identified; work force and organisation,  
23  
24 quality, plant capacity, operations planning, process, environmental management  
25  
26 systems, and vertical integration were the most important decisions with respect to  
27  
28 operations or manufacturing systems. These findings are important not only to better  
29  
30 understand our theoretical knowledge dealing with manufacturing decisions, but also  
31  
32 because they have practical implications for operations managers.  
33  
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35  
36 To analyse the relationship between operations efforts area and firm competitiveness,  
37  
38 was conducted a lineal regression analysis. The dependent variable was firm  
39  
40 productivity and the independent variables were each operations decisions area  
41  
42 previously identified. From this analysis, we can conclude that only work force and  
43  
44 organisation, process technology and environment protection significantly influence  
45  
46 firm performance; nevertheless, the model had only a significance of 26%. Although  
47  
48 some new variables should be included in the model, the empirical results obtained here  
49  
50 must be positively considered, taking into account previous empirical studies (see  
51  
52 Vickery, 1991; Kim & Arnold, 1992).  
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4 For managers, these findings highlight the importance of infrastructural decisions, and  
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6 suggest the existence of some critical ones.  
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9 However, these results may imply a challenging question: Are manufacturing decisions  
10 of no relevance? We consider that firm competitiveness depends on other additional  
11 variables that should be included in future research. In short, it is very difficult to  
12 measure the individual influence of operations decisions and to analyse their effects in  
13 isolation.  
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21 In this sense, firms are expected to develop the appropriate changes to achieve better  
22 results. From this point of view, we think that future research must be oriented to  
23 surpass these shortcomings in order to reach a greater understanding about the role of  
24 operations strategies in firm success.  
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Table Caption

**Table 1. Manufacturing decisions or practices**

REFERENCES	STRUCTURAL DECISIONS	INFRASTRUCTURAL DECISIONS
Skinner (1969)	<ul style="list-style-type: none"> <li>▪ Layout and equipment</li> </ul>	<ul style="list-style-type: none"> <li>▪ Control and planning</li> <li>▪ Organisation design and management</li> <li>▪ Human resources</li> <li>▪ Product design</li> </ul>
Wheelwright (1981)	<ul style="list-style-type: none"> <li>▪ Product and process technology</li> <li>▪ Vertical integration</li> <li>▪ Capacity</li> <li>▪ Size and localization</li> </ul>	<ul style="list-style-type: none"> <li>▪ Operations and material planning</li> <li>▪ Organisational design</li> <li>▪ Work force</li> <li>▪ Quality control</li> </ul>
Wheelwright (1978) Hayes & Wheelwright (1984) Hayes, Wheelwright, and Clark (1996)	<ul style="list-style-type: none"> <li>▪ Process technology</li> <li>▪ Vertical integration</li> <li>▪ Capacity planning</li> <li>▪ Facilities (size and localization)</li> </ul>	<ul style="list-style-type: none"> <li>▪ Operations planning and control systems</li> <li>▪ Organisation design</li> <li>▪ Human resources management</li> <li>▪ Quality management</li> <li>▪ Development of new products</li> <li>▪ Systems for measuring human resource performance</li> </ul>
Buffa (1984)	<ul style="list-style-type: none"> <li>▪ Process and product technology</li> <li>▪ Suppliers strategy</li> <li>▪ Capacity and localization</li> </ul>	<ul style="list-style-type: none"> <li>▪ Strategic implications of operations decisions</li> <li>▪ Work design and work force</li> <li>▪ Operations systems</li> </ul>
Fine & Hax (1985)	<ul style="list-style-type: none"> <li>▪ Process technology</li> <li>▪ Vertical integration</li> <li>▪ Capacity</li> <li>▪ Localization</li> </ul>	<ul style="list-style-type: none"> <li>▪ Control Systems</li> <li>▪ Human resources</li> <li>▪ Quality</li> <li>▪ New Products</li> </ul>
Schonberger & Knod (1988)	Not included	<ul style="list-style-type: none"> <li>▪ Operations planning</li> <li>▪ Operations programming</li> <li>▪ Inventory control</li> <li>▪ Maintenance</li> </ul>
Platts & Gregory (1990, 1992)	<ul style="list-style-type: none"> <li>▪ Manufacturing process</li> <li>▪ Suppliers</li> <li>▪ Facilities</li> <li>▪ Capacity</li> </ul>	<ul style="list-style-type: none"> <li>▪ Control systems</li> <li>▪ Quality</li> <li>▪ Human resources</li> <li>▪ New products</li> </ul>
Krajewsky & Ritzman (2000)	<ul style="list-style-type: none"> <li>▪ Technological innovation</li> <li>▪ Capacity and localization</li> <li>▪ Product and process selection</li> <li>▪ Long run objectives definition</li> </ul>	<ul style="list-style-type: none"> <li>▪ Work force</li> <li>▪ Quality management</li> <li>▪ Raw material supply</li> <li>▪ Process and product design</li> </ul>

**Table 2. Literatura Review: Manufacturing Decisions**

<b>Structural Decisions</b>	<b>Technology</b>	Technology process	Schroeder <i>et al.</i> (1986)
		Advanced Manufacturing Technology investments (design and production)	Ferdows <i>et al.</i> (1986), Ward <i>et al.</i> (1988), Roth and Miller (1990), Horte <i>et al.</i> (1991), De Meyer (1992), Miller <i>et al.</i> (1992), Tunälv (1992), Ward <i>et al.</i> (1994), Kim and Arnold (1996), Boyer (1998), Avella <i>et al.</i> (1999), Boyer and McDermott (1999), Narasimhan <i>et al.</i> (2005), Swink <i>et al.</i> (2005)
		AMT investments (administrative)	Boyer (1998), Boyer and McDermott (1999), Narasimhan <i>et al.</i> (2005), Swink <i>et al.</i> (2005)
	<b>Installations</b>	Focus of facilities	Schroeder <i>et al.</i> (1986)
		Reconditioning of physical plant	Ferdows <i>et al.</i> (1986), De Meyer (1992), Miller <i>et al.</i> (1992), Avella <i>et al.</i> (1999)
		Plant location and re-location	Ferdows <i>et al.</i> (1986), Ward <i>et al.</i> (1988), Schroeder <i>et al.</i> (1986), De Meyer (1992), Miller <i>et al.</i> (1992), Kim and Arnold (1996), Avella <i>et al.</i> (1999)

		Plant capacity	Ward <i>et al.</i> (1988), Roth and Miller (1990), Horte <i>et al.</i> (1991), De Meyer (1992), Tunälrv (1992), Avella <i>et al.</i> (1999)
	<b>Vertical integration</b>	Cooperation with suppliers	Ferdows <i>et al.</i> (1986), Schroeder <i>et al.</i> (1986), Avella <i>et al.</i> (1999), Narasimhan <i>et al.</i> (2005), Swink <i>et al.</i> (2005)
		Sub-contracting	Avella <i>et al.</i> (1999)
		Integrating information systems with suppliers	Ferdows <i>et al.</i> (1986), Ward <i>et al.</i> (1988), Roth and Miller (1990), De Meyer (1992), Miller <i>et al.</i> (1992), Kim Arnold (1996), Avella <i>et al.</i> (1999), Narasimhan <i>et al.</i> (2005), Swink <i>et al.</i> (2005)

<b>Infrastructural decisions</b>	<b>Quality Management Systems</b>	Quality product	Schroeder <i>et al.</i> (1986)
		Total quality management	Ferdows <i>et al.</i> (1986), Ward <i>et al.</i> (1988), Horte <i>et al.</i> (1991), De Meyer (1992), Miller <i>et al.</i> (1992), Tunälrv (1992), Kim and Arnold (1996), Avella <i>et al.</i> (1999), Narasimhan <i>et al.</i> (2005), Swink <i>et al.</i> (2005)
		Zero defect programs	
		Statistical quality control	
		Preventive maintenance	
	Continuous quality improvement (quality circles)	Swink <i>et al.</i> (2005)	
	<b>Production planning/ Inventory management systems</b>	Inventory level	Schroeder <i>et al.</i> (1986)
		Definition operations objectives	Avella <i>et al.</i> (1999)
		Production/Inventory control systems	Ferdows <i>et al.</i> (1986), Ward <i>et al.</i> (1988), Horte <i>et al.</i> (1991), De Meyer (1992), Miller <i>et al.</i> (1992), Tunälrv (1992), Kim and Arnold (1996), Avella <i>et al.</i> (1999)
		Reduction time to prepare machinery	Ward <i>et al.</i> (1988), Roth and Miller (1990), Horte <i>et al.</i> (1991), De Meyer (1992), Tunälrv (1992), Avella <i>et al.</i> (1999)
		Manufacturing lead time reduction	
	Just in time purchasing management	Ferdows <i>et al.</i> (1986), Roth and Miller (1990), De Meyer (1992), Miller <i>et al.</i> (1992), Tunälrv (1992), Avella <i>et al.</i> (1999), Narasimhan <i>et al.</i> (2005), Swink <i>et al.</i> (2005)	
	<b>Work Force Management</b>	Job enlargement	Ferdows <i>et al.</i> (1986), Schroeder <i>et al.</i> (1986), Roth and Miller (1990), Horte <i>et al.</i> (1991), De Meyer (1992), Miller <i>et al.</i> (1992), Tunälrv (1992), Ward <i>et al.</i> (1994), Kim and Arnold (1996), Boyer (1998), Boyer and McDermott (1999), Avella <i>et al.</i> (1999)
		Job enrichment	
		Teamwork	
		Worker training	
		Managers training	
		Work force management	Schroeder <i>et al.</i> (1986)
		Direct labor motivation	Ward <i>et al.</i> (1988), Roth y Miller (1990), De Meyer (1992), Tunälrv (1992), Ward <i>et al.</i> (1994), Boyer (1998), Boyer McDermot (1999)
	<b>Manufacturing Organisation</b>	Professional and managerial development	Schroeder <i>et al.</i> (1986)
		Manufacturing reorganisation	Ferdows <i>et al.</i> (1986), Ward <i>et al.</i> (1988), De Meyer (1992), Miller <i>et al.</i> (1992)
		Multi-functional Project teams	Ferdows <i>et al.</i> (1986), Horte <i>et al.</i> (1991), Miller <i>et al.</i> (1992), Tunälrv (1992), Boyer and McDermott (1999), Avella <i>et al.</i> (1999)
		Reducing size manufacturing workforce	Ward <i>et al.</i> (1988), Roth and Miller (1990), Horte <i>et al.</i> (1991), De Meyer (1992), Tunälrv (1992), Avella <i>et al.</i> (1999)
		Decentralising	
		Changing labour-management relations	
		Improving worker safety	

**Table 3. Measures of variables**

STRUCTURAL DECISIONS		INFRASTRUCTURAL DECISIONS	
<i>Plant Capacity</i>	<ul style="list-style-type: none"> <li>▪ Re-configuration of plant layout</li> <li>▪ Reconditioning of physical plant</li> <li>▪ Investment in plant, equipment and R+D</li> <li>▪ Capacity expansion</li> </ul>	<i>Work Force Management</i>	<ul style="list-style-type: none"> <li>▪ Giving workers a broad range of task (job enlargement)</li> <li>▪ Giving workers more planning responsibility (job enrichment)</li> <li>▪ Teamwork</li> <li>▪ Worker training</li> <li>▪ Management training</li> </ul>
<i>Localization</i>	<ul style="list-style-type: none"> <li>▪ Plant location and re-location</li> </ul>		
<i>Process Technology</i>	<ul style="list-style-type: none"> <li>▪ Computer aided Design (CAD)</li> <li>▪ Computer aided Manufacturing (CAM)</li> <li>▪ Robots</li> <li>▪ Flexible Manufacturing Systems</li> </ul>	<i>Quality Management</i>	<ul style="list-style-type: none"> <li>▪ Total Quality Management (TQM)</li> <li>▪ Zero defect programs</li> <li>▪ Quality circles</li> <li>▪ Statistical quality control</li> <li>▪ Preventive maintenance</li> <li>▪ Continuous quality improvement</li> <li>▪ ISO 9000</li> </ul>
<i>Vertical Integration</i>	<ul style="list-style-type: none"> <li>▪ Sub-contracting</li> <li>▪ Cooperation with suppliers</li> <li>▪ Integrating information systems with suppliers</li> </ul>		
<i>Environm. Protection Programs</i>	<ul style="list-style-type: none"> <li>▪ Environmental Management Systems</li> <li>▪ ISO 14001</li> </ul>	<i>Manufacturing Organisation</i>	<ul style="list-style-type: none"> <li>▪ Decentralising</li> <li>▪ Improving relations between management and workers</li> <li>▪ Improving worker safety</li> <li>▪ Multi-functional project teams</li> </ul>

**Table 4. Grouping, by main activity, of firms from initial sample and firms responding to questionnaire**

CNAE	DESCRIPTION OF ACTIVITY	N° FIRMS	% TOTAL SAMPLE	N°. RESPONSES	% RESPONSES
27	Metallurgy	193	10.60	36	10.19
28	Manufacture of metallic products, except machinery and equipment	575	31.59	106	30.07
29	Manufacture of machinery and mechanical equipment	440	24.18	81	22.94
30	Manufacture of office machines and computing equipment	17	0.93	6	1.69
31	Manufacture of electrical machinery and material	245	13.46	47	13.31
32	Manufacture of electronic material, radio, TV and communications equipment and receivers	85	4.67	14	3.96
33	Manufacture of medical-surgical and precision equipment and instruments, optical instruments and clocks	65	3.57	11	3.11
34	Manufacture of motor vehicles, trailers and semi-trailers	200	11.00	52	14.73
<b>TOTAL</b>		<b>1820</b>	<b>100</b>	<b>353</b>	<b>100</b>

**Table 5. Analysis of systematic bias in terms of industry**

Mean whole sample	Mean study firms	Difference of means	Confidence interval		t	Sig.
			Lower	Higher		
<b>12.5</b>	<b>11.3</b>	<b>0.092</b>	<b>-1.3862</b>	<b>0.5795</b>	<b>0.120</b>	<b>0.951</b>

Table 6. Descriptive analysis for manufacturing decisions

STRUCTURAL DECISIONS	Mean	Stand. Desv.	INFRASTRUCTURAL DECISIONS	Mean	Stand. Desv.
Re-configuration of plant layout	5.07	1.25	Job enlargement	4.78	1.42
Reconditioning of physical plant	5.26	1.20	Job enrichment	5.06	1.34
Investment in plant., equipment and R+D	5.46	1.24	Teamwork	5.40	1.31
Capacity expansion	5.28	1.33	Worker training	5.70	1.06
Plant location and re-location	3.23	1.85	Management training	5.52	1.24
Computer aided Design (CAD)	5.01	1.63	Total Quality Management (TQM)	5.61	1.23
Computer aided Manufacturing (CAM)	4.05	1.80	Zero defect programs	4.90	1.59
Robots	3.71	1.91	Quality circles	4.76	1.49
Flexible Manufacturing Systems	5.15	1.76	Statistical quality control	5.19	1.32
			Preventive maintenance	5.25	1.32
			Continuous quality improvement	5.69	1.09
			ISO 9000	5.74	1.19
Sub-contracting	4.48	1.66	Production/Inventory control systems	5.36	1.17
Cooperation with suppliers	5.09	1.36	Reduction time to prepare machinery	4.94	1.59
Integrating information systems suppliers	4.04	1.53	Manufacturing lead time reduction	5.53	1.25
			Just-in-time purchasing management	4.81	1.54
Environmental Management Systems	4.99	1.47	Decentralising	4.45	1.45
ISO 14001	4.89	1.52	Improving relations managers-workers	5.10	1.47
			Improving worker safety	5.31	1.25
			Multi-functional project teams	4.62	1.46

Table 7. Rotated components matrix

Items	1	2	3	4	5	6	7	Factors
Job enrichment	<b>0.759</b>	0.124	0.309	0.010	-0.001	0.008	0.185	<b>Factor 1</b> Workforce and Organisation
Teamwork	<b>0.727</b>	0.187	0.245	-0.016	0.069	0.006	0.121	
Improving relations management workers	<b>0.695</b>	0.062	-0.027	0.186	0.159	0.088	0.031	
Decentralising	<b>0.663</b>	0.102	-0.069	0.152	0.123	0.090	0.077	
Job enlargement	<b>0.633</b>	0.039	0.237	0.195	0.029	0.185	0.165	
Worker training	<b>0.563</b>	0.421	0.151	0.221	0.029	0.003	0.164	
Improving worker safety	<b>0.509</b>	0.352	0.147	0.125	0.019	0.239	0.011	
Multi-functional project teams	<b>0.503</b>	0.115	0.106	0.095	0.138	0.457	0.027	
Management training	<b>0.399</b>	0.316	0.066	0.276	0.073	0.120	0.217	
Statistical quality control	0.078	<b>0.710</b>	0.131	0.265	0.092	0.067	0.137	
ISO 9000	0.138	<b>0.654</b>	0.083	0.034	0.010	0.217	0.227	<b>Factor 2</b> Quality
Quality circles	0.093	<b>0.647</b>	0.084	0.125	0.084	0.154	-0.014	
Total Quality Management (TQM)	0.285	<b>0.612</b>	0.001	-0.023	0.120	0.444	0.057	
Zero defect programs	0.116	<b>0.598</b>	0.056	0.015	0.305	0.216	0.009	
Preventive maintenance	0.278	<b>0.556</b>	0.100	0.132	0.253	-0.021	-0.022	<b>Factor 3</b> Plant Capacity
Reconditioning of physical plant	0.190	0.043	<b>0.810</b>	0.209	0.120	0.048	0.039	
Re-configuration of plant layout	0.137	0.077	<b>0.808</b>	0.198	0.061	0.137	0.037	
Investment in plant, equipment and R+D	0.069	0.111	<b>0.585</b>	0.002	0.170	0.143	0.233	<b>Factor 4</b> Production Planning
Capacity expansion	0.205	0.190	<b>0.536</b>	0.137	0.118	-0.051	-0.010	
Manufacturing lead time reduction	0.214	0.117	0.188	<b>0.760</b>	0.145	0.057	0.041	<b>Factor 5</b> Process Technology
Production/Inventory control systems	0.138	0.226	0.248	<b>0.713</b>	0.175	-0.028	0.164	
Just-in-time purchasing management	0.181	0.133	0.059	<b>0.527</b>	-0.077	0.183	0.272	
Continuous quality improvement	0.310	0.419	0.196	<b>0.514</b>	0.136	-0.061	-0.014	<b>Factor 6</b> Environment
Computer aided Manufacturing (CAM)	0.054	0.163	0.073	0.155	<b>0.771</b>	0.126	0.177	
Flexible Manufacturing Systems	0.147	0.168	0.125	0.021	<b>0.712</b>	-0.049	0.070	<b>Factor 7</b>
Robots	0.078	0.104	0.064	0.166	<b>0.540</b>	0.196	0.004	
Computer aided Design (CAD)	-0.038	0.073	0.249	-0.168	<b>0.497</b>	-0.078	0.456	
Reduction time required prepare machinery	0.375	0.219	0.151	0.340	<b>0.438</b>	0.046	-0.103	
ISO 14001	0.064	0.327	0.040	0.042	0.012	<b>0.803</b>	0.087	
Environmental Management Systems	0.220	0.306	0.128	0.029	0.157	<b>0.750</b>	0.032	
Sub-contracting	0.106	0.008	0.043	0.050	0.096	0.013	<b>0.780</b>	

Cooperation with suppliers	0.262	0.201	0.070	0.249	0.051	0.018	<b>0.645</b>	Vertical Integration
Integrating information systems suppliers	0.203	0.132	0.023	0.130	0.133	0.260	<b>0.589</b>	
Plant location and re-location	0.003	0.213	0.180	-0.033	0.080	-0.205	<b>0.207</b>	

Extraction method: principal components analysis. Rotation method: Kaiser Varimax Normalization.

	Non-standardized Coefficients		Standardized Coefficients	t	Sig.	FIV
	B	Typ. error	Beta			
(Constant)	169.4	9.091		18.64	.000	
Factor 1: Workforce and Organisation	11.62	9.104	.067	1.547	.100**	1.000
Factor 2: Quality	1.928	9.104	.011	.212	.832	1.000
Factor 3: Plant capacity	-2.407	9.104	-.014	-.264	.792	1.000
Factor 4: Production Planning	8.945	9.104	.051	.983	.327	1.000
Factor 5: Process Technology	20.45	9.104	.117	2.247	.025*	1.000
Factor 6: Environment Protection	26.36	9.104	.151	2.896	.004*	1.000
Factor 7: Vertical Integration	-12.66	9.104	-.073	-1.391	.165	1.000

\*p<0.05

\*\*p<0.10