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Manufacturing strategy and competitiveness

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Abstract

The importance of manufacturing strategy (MS) has never been questioned and has been emphasized in many theoretical concepts, frameworks, and models. There are only a few empirical studies, however, which examine whether these theories work in practice. In this paper the hypothesis that the existence of MS contributes to company level competitiveness (ROS, inventory turnover) is tested.

The study is based on international data, which were collected in the second round of the International Manufacturing Strategy Survey. The database contains more than 700 companies from the machinery industry (ISIC 381–385), from 23 countries.

The results partially support the hypothesis. The existence of MS seems to have a positive effect on ROS, however, it does not have any relation to inventory turnover.

Keywords: Manufacturing strategy; Competitiveness; Empirical analysis; IMSS data

1. Introduction

Is there a connection between production competence and business competitiveness? The majority of respondents would give a positive answer like in Schroeder et al. (1986), 80% of production managers answered this question affirmatively. Intuitively, it seems obvious that a smoothly running production system will have a positive influence on business performance. In the literature of production strategy—at the level of theories and concepts—it is discussed by several authors, like for the advantages and positive effects of production focus see the work of Skinner (1969, 1974), for positioning production systems in product-process matrix and the strategic roles of manufacturing see Hayes and Wheelwright (1979a, b), Wheelwright and Hayes (1985), and for order winning criteria see Hill (1993). The statement seems to be logical since every new concept or method can prove that its existence—directly or indirectly—contributes to the business performance. The scientific and business world, however, are not satisfied by pure theoretical constructs. They require empirical support, such as case studies or other empirical procedures.

2. Literature review

Studies dealing with the connection between *business strategy* and *business performance* have played an important role (for example, see Pearce et al., 1987; Cool and Schendel, 1987; Banker et al., 1996) in the development of production strategy in

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the direction of operationalization, arising questions, and elaborating methodology.

The body of empirical research in production strategy is not large (there is a summarizing table about it in Swink and Way (1995), and this is the topic of the paper by Minor et al. (1994)). However, there are several studies dealing with the testing of some concepts, model building, and operationalizing these models. The main task in many of these studies is to examine *production and business performance* in terms of the effect on the production field.

For example, a frequently raised question is, what kind of influence a characteristic of the production system exerts on business performance. Phillips et al. (1983) examined the effect of product quality on business performance and cost, supporting the idea that focusing on one specific competitive edge for the business can help in reaching competitiveness. De Meyer and Ferdows (1990) analysed the connection between production programs and production performance. They concluded that it is not enough to implement several production programs, a well-developed portfolio, or in other words, existing concept behind is necessary to get high-production performance. Ahmed et al. (1996) have reached a similar conclusion. Beaumont and Schroeder (1997) have looked at the connection between technology and performance. Their results were not obvious, some technology affected business performance positively, but others did not affect it or even had a negative effect on the performance. These studies support the idea that the existence of a strategic view in manufacturing is necessary in order to reach business success.

Several authors have examined the consistency between production and business strategy (Richardson et al., 1985; Deane et al., 1990; Brown, 1998), and within this issue there is a separate group dealing with the connection between production competence and business performance (Cleveland et al., 1989; Vickery et al., 1993; Kim and Arnold, 1996; Corbett and Van Wassenhove, 1993) where they defined production competence as the level of consistency between importance and performance of competitive priorities. They argued that the larger the consistency, the more manufacturing can contribute to business success. Thus, these papers again support the idea that handling manufacturing strategically contributes to business performance.

The effect of production strategy—interpreted overall, or operationalized by one or two variables—on business performance is in the centre of Swamidass and Newell (1987), Roth and Miller (1992), both emphasizing the role of managers, and Milling et al. (1999). The existence of production strategy and its effects are analysed in Tunälv (1992). The latter group of studies have the closest connection to the topic of this paper.

In Table 1 there is a chronological summary of empirical studies dealing with factors which affect production and/or business performance. In the table, the author, the examined sample, the applied method, the most important questions, and the results of the analysis are listed.

Inventories appear in this table only indirectly in some production programs like MRP or JIT, as a source (cause) of business competitiveness. Taking inventories as a measure of business level performance (effect) is very rare in the research literature, in spite of the fact that inventory turnover is one of the most frequently used performance measure in evaluating operating performance within Fortune 500 companies (Hendricks, 1989). Since inventory turnover is affected by several internal and external factors, like the type of industry, company size, level of centralization in purchasing, characteristics of the market, just to mention a few, thus this measure is more applicable to control changes within a company than to compare business performances.

3. The hypothesis

As seen in Table 1, several experts have examined the issue of connecting Manufacturing Survey (MS) to business performance. Although their results are not always evident, it seems that there is a connection on some level. The hypothesis of this study: *The existence of MS, by itself, positively influences business performance.*

Table 1
Empirical studies on the effects of manufacturing strategy (MS) on production competence and business performance

Authors	Sample/method	Question	Result
Phillips et al. (1983)	623 companies (PIMS database) 2 periods, path analysis	The effect of product quality on cost and business performance	Product quality affects market position positively, and through this effect has a positive influence on business performance (ROI) and direct costs.
Richardson et al. (1985)	64 Canadian electronical company, regression, correlation	Analysis of the consistency between corporate mission and manufacturing task; the effect of focus and consistency on corporate performance	Plant focus and size does not matter, corporate focus, harmony and orientation (technology vs. cost) does; technology orientation is more viable.
Swamidass and Newell (1987)	35 American companies, regression	The effect of environment on business performance through production strategy	Higher level flexibility and involving production managers in decision making leads to better performance and helps in handling environmental uncertainty.
Cleveland et al. (1989)	6 companies, regression	Connection between production competence (the importance vs. capabilities of strategic areas) and business performance	Close connection between production competence and business performance (production, marketing and financial performance) ($r^2 = 0.97$).
Deane et al. (1990)	217 new entrepreneurship, comparison, *t*- and *F*-tests	The effect of consistency between production and business strategy on business performance	Successful companies combine cost leader strategy with production strategy with positive outcomes (this is not true for differentiation).
De Meyer and Ferdows (1990)	167 European companies (1987 MFS database), stepwise regression	The effect of using production programs on production performance	There is no simple cause and effect relationship between production programs and production performance; a well selected portfolio of programs is needed to reach production success.
Tunälv (1992)	184 Swedish companies (on the basis of MFS)	The existence of MS, and its effect on production and business performance.	Companies possessing production strategy have a higher return on sales ratio.
Roth and Miller (1992)	180 American companies (1988 MFS), cross tables, cluster analysis, significance tests	The effect of MS on business performance (ROA, profit) (transitory variables: production performance, managerial success)	A good manager is better than world class manufacturing; success factors of building production competence: resource development, quality management and developed process technology.
Vickery et al. (1993)	65 furniture companies, linear regression	The effect of production competence and business strategy on each other and on business performance	Weak positive connection between production competence and business performance; production is important to reach business success in case of pure differentiation strategy.
Kim and Arnold (1996)	182 American companies (1990 MFS database), competitiveness map, regression	The level of production competence (the importance vs. performance of competitive priorities) and its effect on	It is worthwhile to concentrate on some selected competitive priorities; production competence is significantly connected with

Table 1 (*continued*)

Authors	Sample/method	Question	Result
		business performance	ROA and profit ratio (not with growth and market share).
Ahmed et al. (1996)	655 companies, comparisons, groupings with tests	The effect of using production programs on business performance (created from 12 variables)	The use of one production program has a positive effect on business performance; using 2 or 6 programs does not cause significant difference.
Beaumont and Schroeder (1997)	962 Australian companies, *t*-test, Mann–Whitney *U* test	The effect of using technologies on production and business performance	The use of technologies generally does not have a significant effect on production and business performance (exceptions: TQM, LAN, EDI positive, CAD/CAE negative effect).
Brown (1998)	29 companies, simple comparison	Cohesion of production and business strategy; the effect of MS on quality performance of plants	Traditional and enlightened companies; MS exists at enlightened companies, it is consistent with business strategy and these companies have a better quality performance.
Milling et al. (1999)	155 companies, linear regression	The effect of MS (objective, focus, level of usage) on production performance	A MS aimed at reducing costs leads to higher cost efficiency; other results of MSs

4. The survey

This study is based on the International Manufacturing Strategy Survey (IMSS), which tries to discover the production strategies of companies all over the world from the Manufacturing Industry within the Division of Fabricated Metal Products, Machinery, and Equipment (ISIC 38). Restricting the survey to the machine industry can be explained by the international nature, which in itself causes a lot of variations, and also by the relevance of the questionnaire, which can be more industry specific in this way.

The topics included in the questionnaire are related to: (a) business characteristics and strategies, (b) the various parts of production strategy (facilities, production process and technology, capacity planning, organization, production planning and control systems, quality, product development and relations to customers/suppliers), (c) production programs used at companies, (d) production performance, and (e) plans for the future. The questionnaires were sent to production managers.

IMSS has had two rounds so far in 1992–1994 and in 1996–1997, the third round is under construction now. The results of IMSS-I are summarized in Lindberg et al. (1998). This study uses the data of IMSS-II. Unfortunately, there are very few companies which participated in both rounds. This makes longitudinal analyses impossible.

5. The sample

IMSS has a centrally suggested data collection method as follows:

1. From each country 30–50 companies are expected. Assuming a 50% answering rate, 60–100 (the largest ones if possible) should be selected for involvement.
2. Preliminary contact is made with the production manager in order to get agreement on participating in the survey.
3. Send the questionnaire to the responding person and trace if needed.

4. Collecting the questionnaires and sending them to the actual centre and coding if possible (in centrally planned and distributed excel database).
5. Getting the international database.

Sources of uncertainty in such an international survey are the differences in the actual method of collecting the data, the environment and knowledge of the responding person, and possible translating problems. The rich database as a counter-value, while keeping uncertainties in mind, is quite useable in empirical analyses.

The IMSS-II database contains the data of 703 companies: Northern Europe is represented by Denmark, Norway, Sweden and Finland (81 observations altogether), Western Europe is represented by the Netherlands, Germany and UK (83 observations), there are Italian and Spanish companies from Southern Europe in the sample (104 observations), 38 companies from Hungary representing Central Europe. There are 82 companies from North America (USA and Canada), 105 companies from Central and South America (Mexico, Argentina, Brasilia, Peru, Chile), 123 from the Far East (China, South Korea, Japan, Hong Kong), and finally 87 companies from Australia and New Zealand (the origin of one company is unknown). The companies represent the machinery industry.

6. Operationalization

In order to examine the connection between the existence of MS and business performance we have to identify the variables involved. The survey does not contain direct data on the existence of MS, therefore we have to construct one.

Let us start from the fact that MS should (a) connect the manufacturing function to business goals, and (b) insure consistency among manufacturing decisions (see e.g., Skinner, 1969). Either it is planned and written down, or done informally, the two criteria mentioned above should be fulfilled to consider MS as an existing one. A formalized MS is not proof of the existence of MS (although it can be the first step), since plans and activities do not always fit with each other. Not only are the planned decisions of interest, but also the activities and their results.

Tunälv (1992) considered MS as existent during the operationalization of MS if competitive priorities stated by the company and manufacturing objectives selected are in harmony with each other, and also if the time horizon of manufacturing objectives is longer than 1 year. This definition of the existence of MS is supported by his database with two additional thing: on the one hand, the group without MS indicated significantly more problems occurring concerning the understandability of objectives and strategies; on the other hand, the number of written MSs was significantly lower in this group.

Concerning business performance, it is obviously very difficult to create a single measure for business success. Therefore, the connection between manufacturing and all the available and generally accepted measures of business performance were analysed.

Before going further, it is worth noting that the cause and effect relationship cannot be identified from these analyses. If the hypothesis is supported, we will not be able to tell if business performance is due to the existence of MS, or if MS exists because business performance is good (and there is time, money, and energy to define and continuously adapt MS).

The data used and the method applied in this study are as follows:

1. *Competitive priorities* and the *importance of manufacturing performances,* which we want to compare, are explored in separate groups of questions. These two groups complement each other in the following points (examining exclusively the field of production):

Competitive priorities	Importance to manufacturing
⇒ selling price	— average unit manufacturing cost
⇒ manufacturing quality	— conformance to specification
⇒ delivery time	— manufacturing lead time

⇒	delivery dependability	— on time deliveries
⇒	product range	— product variety
⇒	order size flexibility	— equipment changeover time

Obviously, the exact list of factors within the two groups of variables are specific to IMSS-II, however, they are generally accepted in international surveys. Also, it should be emphasized that the pairs created are the consequence of data availability, e.g. order size flexibility is not only related to equipment changeover time, but also to resource availability and productive capacity.

The six pairs of variables above are all measured on a 1–5 Likert scale, where 1 stands for very low priority, or importance, and 5 stands for very high priority or importance. For each company and each dimension the differences were counted (six pairs of variables yields six differences per company), and the absolute value of these differences were summarized into one single variable, called *inconsistency variable*. For example, let us assume that company 1 marked the following values for competitive priorities: 5 for selling price, 3 for manufacturing quality, and 4, 4, 4, 3, respectively, for other factors. In terms of importance to manufacturing they marked: 5, 4, 5, 3, 2, 3, respectively. The inconsistency variable will be $|5-5|+|3-4|+|4-5|+|4-3|+|4-2|+|3-3|=5$. This new variable shows that there is a large difference between competitive priorities and manufacturing objectives: the larger the value of this variable, the smaller is the consistency. Concerning the average level of the inconsistency variable two groups were created: the group of companies with MS, and the group of companies without MS.

How reliable is this grouping? An important checking point is to examine the company's answers to the questions, analysing the connection between manufacturing and business strategy. One of these questions considers the extent to which the organization translates business goals into MS, and the other the extent to which manufacturing influences the development of business strategies.

Furthermore, a logical assumption would be that companies having MS put a greater emphasis on feedback, that is, they measure whether the goals, objectives and tasks were fulfilled or not. Thus, as expected, this group uses performance measures more frequently. This question is also analysed.

2. The data in the IMSS database does not yield much information from which to measure business performance. Nevertheless, the return on sales (counted as the ratio of profit before tax to sales, ROS), the inventory turnover, and the domestic market share are available.
3. Analysis of variance (F-test) is used to test the differences between business performance in the two groups.[1]

7. The results

The inconsistency variable, stemming from the differences of the six selected manufacturing objectives and business goals, has an average between 5 and 6 (this means almost a one unit difference by one variable, and remember, the larger the difference, the larger the inconsistency). There were 444 companies answering each question, and 254 of them had a value of less than or equal to 5. These form the group of companies having MS. The other 190 companies form the group of companies not having MS. Some of the characteristics of the two groups are summarized in Table 2.

The most important result in the table is that ROS is significantly higher in companies with existing MS (as in Tunälv, 1992).[2] Moreover, the grouping is supported by the variable, which measures the extent to which manufacturing influences the development of business strategy.

[1] F-test is the final significance test of whether or not a variable discriminates between groups. F is essentially computed as the ratio of the between groups variance in the data over the pooled (average) within-group variance. If the between-group variance is significantly larger, then there must be significant differences between means.

[2] The connection between the existence of MS and ROS is particularly strong for more developed regions, like Northern- and Western Europe, North America and Asia. A separate analysis on these regions has a significance level of 0.019, although the number of observations was 156 (while it was 288 in the total sample).

Table 2
Some characteristics of groups with and without MS

Variable	MS exists	No. MS	F value
Domestic market share (%)	42.6%	45.4%	0.9
Number of employees	1607	1116	1.7
Translating BS into MS (1–5 scale)	3.77	3.65	1.5
Influence of manufacturing on BS (1–5 scale)	3.36	3.18	3.0*
Inventory turnover	11.6	15.0	2.1
Return on sales (%)	12.0%	8.8%	4.2**

*Significant at 10% level.
**Significant at 5% level.

The latter is in accordance with the results of Swamidass and Newell (1987), who emphasized the importance of involving production managers in decision making in order to reach better performance.

Although by looking at the data there seem to be a difference (with the advantage of companies with no MS!) in inventory turnover, the statistical test does not confirm the difference. In other words, it means that the existence of manufacturing strategy does not necessarily results in better inventory turnover. This result supports the usual approach which does not take inventory turnover into account as a performance measure in inter-company comparisons.

We now examine whether the use and importance of performance measures support this grouping. This is shown in Table 3.

Materials and overhead costs is the only performance measure in Table 3 which is used more significantly in companies without MS than in the other group. Moreover, manufacturing quality, product development features, and the time factors (including inventory turnover) are significantly less important in these companies. The latter results seem to be relevant. We all know that quality and product development are important to the future of the company and neglecting them mirrors the lack of strategic thinking (see also the results of Roth and Miller (1992)). Also, the process view and time-based competition emphasize that more attention should be paid to time factors.

Thus, the results support our hypothesis, companies with MS give more importance to performance measures than companies without MS.

8. Conclusions

The existence of MS contributes positively to company performance, measured as ROS, on the basis of the statistical analyses on IMSS II data. This supports the results of Tunälv (1992) who analysed the same question (although on the MFS database) and found the same result. On the other hand, manufacturing strategy does not seem to effect inventory turnover. Intuitively, other factors like industry or company size are more important affecting factors here.

Results in this paper also show that the existence of manufacturing strategy usually implies heavy involvement of production managers in the decision making process, or at least manufacturing at this level (with existing MS) should somehow channel important information towards business strategy.

Finally, the strategic view, at the level of manufacturing, results in more attention towards quality, product development, and time factor issues, and less direct attention to costs. Inventory turnover is also more important to companies with MS, although there is practically no difference in the use of this measure. Looking beyond the rationale of these results, the behaviour of companies having MS is in accordance with the suggestions of the sand cone model (Ferdows and de Meyer, 1990).

Table 3
Use and importance of performance measures in groups with and without MS

Variable	Use (1—yes, 0—no)			Importance (1—low, 5—high)		
	MS exist	No. MS	F value[1]	MS exist	No. MS	F value
Market share	0.74	0.74	0.0	4.12	3.86	5.2**
Customer service	0.62	0.66	0.8	4.24	4.13	1.2
Customer satisfaction	0.64	0.64	0.0	4.55	4.49	0.6
Manufacturing quality	0.92	0.86	3.6*	4.58	4.29	14.8***
Product variety	0.59	0.50	3.3*	3.34	2.79	24.0***
Product development time	0.60	0.49	4.5**	3.87	3.20	33.1***
Number of new products	0.73	0.55	14.3***	3.56	2.85	38.2***
Profitability	0.98	0.94	4.6	4.69	4.53	4.9**
Return on investment	0.88	0.83	1.8	4.21	3.99	4.5**
Average unit manufacturing cost	0.91	0.86	3.0*	4.24	3.95	8.6***
Materials and overhead costs	0.94	0.98	3.9*	4.31	4.25	0.6
Manufacturing lead time	0.87	0.81	2.5	4.14	3.71	22.9***
Equipment changeover time	0.57	0.50	2.3	3.30	2.78	21.9***
Procurement lead time	0.64	0.58	1.4	3.67	3.22	17.4***
Delivery time	0.87	0.82	1.4	4.25	3.89	15.8***
Inventory turnover	0.89	0.89	0.0	3.92	3.54	15.0***
On-time deliveries	0.89	0.87	0.5	4.48	4.34	3.1*
Supplier quality	0.88	0.86	0.5	4.29	4.18	2.0
Employee satisfaction	0.45	0.47	0.2	3.72	3.61	0.9
Worker productivity	0.85	0.82	0.6	4.04	3.88	3.1*
Work place safety	0.84	0.78	2.1	4.33	4.61	0.4
Energy consumption	0.73	0.71	0.3	3.27	3.01	5.9**
Product recyclability	0.30	0.25	1.6	2.80	2.75	0.0
Waste recyclability	0.41	0.35	1.6	3.04	2.97	0.0

*Significant at 10% level.
**Significant at 5% level.
***Significant at 1% level.

One can argue that these results may be industry specific. In some sense this argument is true, since we had a limited number of industries. However, according to Boone and Whybark (1995a, b), who analysed differences between two very different industries (small machine tool and textile industries) using an international database, differences in manufacturing practices between countries are much greater than those between industries, which is due to the special economic, legal, and cultural environment in various countries.

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