015-0767

CONGRUENCY FIT: BEYOND PERFORMANCE IN THE AUTO SUPPLIER INDUSTRY

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POMS 21st Annual Conference
Vancouver, Canada
May 7 to May 10, 2010

ABSTRACT

The effects of manufacturing strategy (MS) and technology (T) on performance have been studied separately, but few studies have examined the relationship between MS and T practices clusters that improve effectiveness when implemented jointly, and even then they do not consider possible congruency between the two. This paper develops a congruency (selection) model to test for any interconnection between said clusters, without addressing causation or their combined effect on performance. The implicit outcome is that the plant will achieve a desirable effectiveness level. Through a wide-ranging survey of auto supplier plants, two approaches are considered: 1) grouping both clusters in pairs (canonical correlation analysis); and 2) a more general selection view version, with practices from both clusters related multidimensionally and subordinated by bivariate analysis (regression) to test for any congruent pattern. Both methods find a congruent relationship between manufacturing strategy and technology practice clusters, although the second provides greater detail.

Keywords: Manufacturing Strategy, Technology, Congruency, Selection, Fit.

1. INTRODUCTION

The idea behind the High Performance Manufacturing (HPM) view is that each manufacturing plant must find its own unique path to high performance, based on contingent factors and the links between manufacturing practices. Previous studies on this topic still shed little light on the reasons why the application of the same manufacturing practices fosters high performance in some plants, but not in others (see Primrose, 1992). One HPM proposition is that the lack of success in some plants may be partially due to a faulty correlation between practices (Schroeder and Flynn, 2001). Starting from this foundational idea of interconnection, the present study examines the effect of the link between manufacturing strategy (MS) and technology (T) operations practices sets.

However, Morita and Flynn's paper (1997) is the only study part of the publication of the HPM book edited by Schroeder and Flynn (2001), directly concerned with the relationship between MS and technology. Nevertheless, it does not do it in an exclusive or exhaustive way, since, on the one hand, it approaches the relationship of MS (considering only strategic adaptation) with other practices and, on the other hand, it only takes on board the concept of technological adaptation with its scales. The authors do indicate, however, that there is an important link between this technological concept and strategic adaptation.

Since said book, only three works in the HPM research have directly examined this important subject. In these papers, there are findings that tend to confirm the importance of this relationship. Matsui (2002) studies the contribution of different practices (including MS) in the development of technology, in three dimensions of process and product technology (effective implementation of processes, interfunctional design effort, simplicity of product design). Parts of his results constitute clear evidence that the participation of manufacturing practices (MS included) in the development of technology has a strong impact on the competitiveness of the production plant. McKone and Schroeder (2002) seek to determine the type of companies making use of process and product technology by taking the relationship within the context of the plant (they include strategic aspects) but without considering performance. Finally, a part of Ketokivi and Schroeder's (2004) study considers the strategic eventualities involved in the adoption and implementation of several manufacturing practices to achieve high performance. However, they include "design for manufacturability" as the only technological variable.

Regarding the general Production and Operations Management (POM) literature, most of the previous studies have explored the relationship between business strategy (not MS) and technology, either in a one-dimensional or a multidimensional way. Some researchers have classified the essential dimensions of technology that are inherent in a specific strategy (e.g. Ford, 1980). On the other hand, Parker (2000) tries to test for current and future dynamic interaction between business strategy and technology and its effect on the plant's performance, but without using a time series (a longitudinal study).

This literature shows some empirical interconnections between specific dimensions of technology and business strategy. Some of the discoveries indicate the need to determine the fit/adjustment between these dimensions (e.g. Parthasarthy and Sethi, 1993).

Some of these studies have indeed proposed integrated models that describe fits/adjustments between several dimensions of technology and business strategy (e.g. Maidique and Patch, 1988). However, they have not empirically shown if there is a relationship of mutual adaptation in the design and implementation of MS and technology, which ensures that only high performance organisations will survive thanks to the existence of a supposed isomorphic process between the two practices (selection fit).

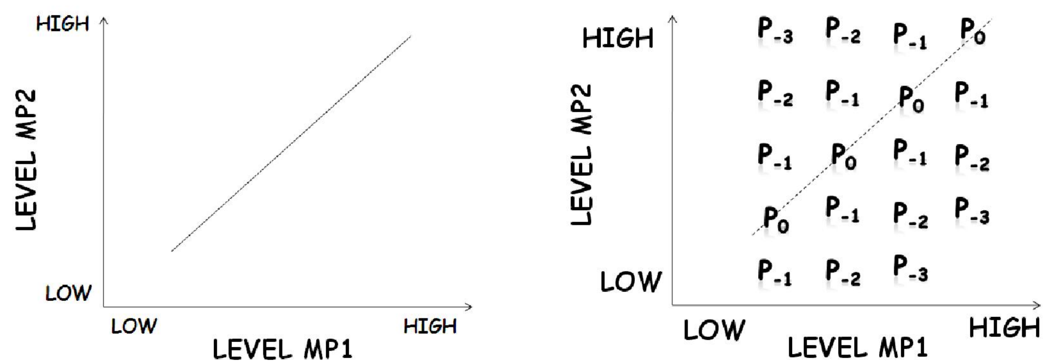
In conclusion, although the above studies have increased the general understanding of strategy-technology relationships, they have not examined the possible congruency/selection aspects of this rapport. Moreover, although they have had an influence on the generation of ideas concerning the relationships between strategy and technology, to date the corresponding empirical validations have been minimal and there have been even fewer regarding MS, since most of these past papers analyse relationships from a business strategy perspective. With this in mind, it is possible to conclude that: 1) the previous research has had fundamentally theoretical orientations and 2) the possible impact of a selective relationship between MS and technology has not been well documented.

Due to the above, it is not clear whether the relationship between MS and technology is inherently selective in its nature. Therefore, the present work tries to shed more light on this subject by verifying a possible congruency between MS and technology.

Some possible relationships from this study's framework with their respective hypotheses are described are presented (section 2). We discuss some constructs/concepts and methods from this work in section 3, and the data collection methods in section 4. Subsequently (section 5), the empirical results are discussed. Finally, in section 6, some conclusions and future research are outlined, highlighting the implications and limitations of this work.

2. ANALYTICAL FRAMEWORK AND HYPOTHESES

The selection model departs from the idea that in order to control or improve a manufacturing practice (MP1), it needs to regulate or adapt its levels taking into consideration the level of another practice (MP2) and/or vice-versa. The key here is the adaptation between manufacturing practices MPs not necessarily their levels. Because a regulation effect exists in the dimensions of both MPs levels involved (e.g. a congruency), it is not expected that this interrelationship will show any differences or variations in terms of performance for such dimensions of each practice levels, thus making a straight line as in Figure 1, a. This figure shows the dimensions aggregate levels of both practices operating efficiently due to a mutual adaptation, where the straight line illustrates the fit between both practices (i.e. alignment between dimensions). A misfit would have resulted in points outside the line (performance variations), allowing for interaction fit and not for selection fit. This is shown in Figure 2, b, where any point, other than P_0, means a performance variation.



a. Selection: no performance variation b. Interaction: performance variation

Figure 1. Fit vs. misfit

The requirements of this adjustment form are very specific, given that there should be a sufficient number of organisations that have adapted the dimensions of one of the manufacturing practices (MP1) to, or associated them with, the dimensions of the other (MP2). In short, there is a state of equilibrium due to a fit between MPs, reflected by the straight line in the figure above.

The congruency perspective (also referred to as selection) studies the fit definition without verifying possible direct impacts of the dependence of the fit on performance. Its importance and the ease with which its functional form of fit can be made operative have meant it has continued to be used throughout the decades from its beginnings in the nineteen-sixties and -seventies up to the present day. This form of fit is the most common in the empirical contingency literature (Drazin and Van de Ven, 1985).

As an illustration, consider a possible survey study examining the relation between the levels of two manufacturing practices sets (MP1&MP2, Manufacturing Strategy and Technology in our case). MP2 may be a univariate variable ranging from a lower implementation MP2 (L) to a higher implementation MP2 (H). MP1 level may also be measured with respect to ‘‘implementation level’’ ranging from lower to higher. Furthermore, assume that H is best supported by a higher level of MP1 implementation, while a lower level of MP1 implementation best serves L. From a Congruence angle of view, one would hypothesize that the higher the level of MP2 implementation, the higher its respective MP1 level (the other way is also possible, where the higher the level of MP1 implementation, the higher its respective MP2 level). Fig. 2a depicts a situation where manufacturing plants in general have adapted their MP2 level to MP1 level in the way theory predicts. It shows levels of both practices operating efficiently due to mutual adaptation, where the straight line illustrates the fit between both practices (both H’s and L’s are adapted and thus aligned). Consequently, there is no reason to suspect any significant variations in performance due to misfit between MP1 and MP2 implementation levels. Figures 2b and 2c show the expected performance level across different levels of MP1 level, where they show no performance difference (both L’s and H’s have same performance). Of course, there may be some variation in performance in reality. However, there is no way to predict such variations from the information given in Figure 2a, since the underlying selection theory (implicitly) presumes that only the best-performing plants survive. In other words, a large number of the plants must adapt their MP1 level to MP2 level; otherwise selection fit cannot be identified. On the other hand, selection implies that there is little to no room for alternative methods such as interaction fit, since interaction requires that less effective adaptations also exist, otherwise there is no way to show that ideal adaptations are related to higher performance, and, at the same time, variations from ideal adaptations are related to lower performance as in Figure 1, b (Gerdin & Greve, 2004).

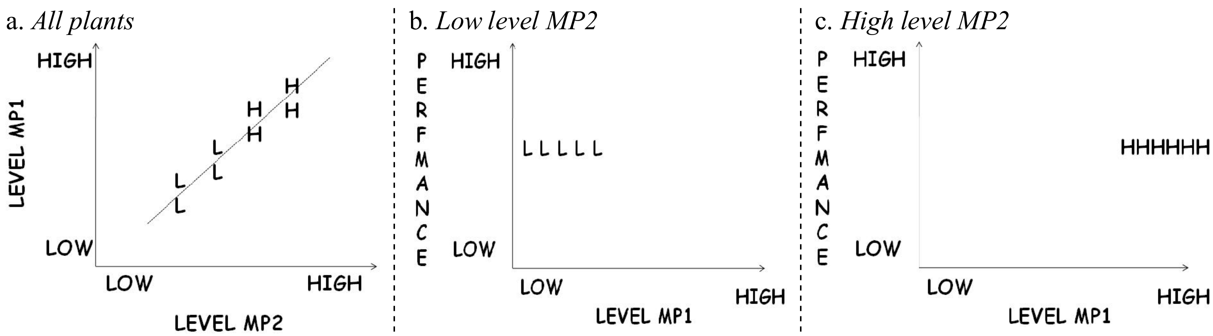


Figure 2. Relationship in Congruency

(Adapted from Gerdin & Greve, 2004)

With the selection view, it will be assumed that weak combinations of elements between MS and technology tend to disappear (due to extinction or due to adaptation). Therefore, the surviving measures and all their combinations should display appropriate congruency.

This study will proceed to examine the way in which technological factors are related to elements of MS without trying to measure whether this association has links to performance. In order to examine this relationship, the identification of specific technology profiles associated with different dimensions of MS will form the hub of this review. This focus does not presume to determine the direction of causation, but rather it presents an avenue for a cross-sectional study, by which it is possible to establish whether congruency exists between MS and technology.

The possibility of a bilateral trajectory between MS and technology is illustrated in the model below, where the connections between both variables are simultaneously examined. Technology may be the independent variable that influences MS and vice-versa. Figure 3, below, known as the “Non-Recursive Reciprocate Model”, shows a bidirectional arrow, where MS and technology are determined in a simultaneous way or at intervals that are too short for causal influences operating in different directions to be empirically distinguished (see Berry, 1984). This model also indicates that, statistically speaking, there is no difference whether the arrow goes from MS to technology or vice-versa (for example Bates et al., 1995). This reinforces what was said above in that this model does not examine the relationship of cause and effect in the search for correlation between these two practices.

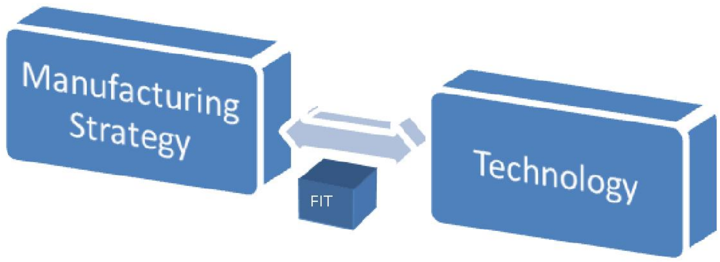


Figure 3. MS-Technology Congruency

The functional form of selection fit is linear correspondence between MS and technology. It is assumed that the non-adjusted/fitted combinations tend to disappear quickly, and that the surviving combinations are those whose MS characteristics are congruent with the characteristics of the technology being used. Thus, the proposal is that a relationship of mutual support exists between MS and technology. With this assumption, it is hoped that it will be possible to test whether there is a bidirectional relationship between MS and technological practices. Therefore, endeavouring to examine this specific interrelationship in greater depth, the requirement of fit can be verified by testing whether there is a state of equilibrium in a sufficient number of plants, where they must therefore have adapted the dimensions of one MP to the dimensions of another (otherwise congruency fit cannot be identified).

Based on the above, it is anticipated that a mutual support relationship exists between the Manufacturing Strategy and technology dimensions. It is hoped that with this supposition it can be tested whether there is a bidirectional relationship between manufacturing strategy and technology. Therefore, we shall propose relationships that demonstrate some kind of congruency:

Hypothesis 1: Congruency is displayed through a bidirectional relationship between Manufacturing Strategy and Technology practices sets.

Hypothesis 2: There is congruency by way of a unidirectional relationship between Manufacturing Strategy and Technology practices sets.

Hypothesis 3: There is congruency by way of a unidirectional relationship between Technology and Manufacturing Strategy practices sets.

3. RESEARCH VARIABLES AND METHODS

In order to operationalize the analytical framework and the hypotheses in the preceding section we first introduce some research variables below (divided into two categories) and next the two methods for the selection model.

3.1. Research Variables

3.1.1. Manufacturing Strategy

MS determines how production supports the general objectives of the plant for competiveness through the appropriate design and use of production resources and capacities. In order to achieve this support, it is essential for MS to be aligned with both marketing strategy and business strategy in general (see Bates et al., 2001). In this study, the following MS aspects of the international HPM research project are covered (Bates et al., 1995; Schroeder and Flynn, 2001):

- Anticipation of new technology
- Formal strategic planning
- Manufacturing-business strategy link

3.1.2. Technology

The international HPM research project assumes a broad definition of technology that includes human and organisational aspects of the way the company operates (Matsui, 2002). Concerning international HPM research, the following parameters are included in the construction of the technological concept for the models that are later proposed (Schroeder and Flynn, 2001; McKone and Schroeder, 2002):

1. As part of product technology (new product development):
    - Interfunctional design efforts
2. As part of process technology
    - Effective process implementation
    - Supplier involvement

3.2. Methods

Some of the advantages of the selection model are its simple procedure and the fact that it does not require the measure of a third variable as an outcome. In addition, it is very straightforward to make the selection method operative by using correlation, regression, analysis of variance (ANOVA), and so on. This work uses both correlation and regression.

As regards this perspective, comparative evaluation of different methods to test fit and the relationship between the results and characteristics of the same sample may help to develop medium-range theories about what approach to take in the sector studied. However, caution should be taken since multiple statistical methods may lead to a triangulation trap, where results may be ambiguous. If results of multiple tests converge, the evidence will carry much weight, but if multiple tests give divergent results, the evidence will not be so robust, and this may indicate two different things: 1) differential support for opposing methodological views; or 2) perspectives may not be evaluated by multiple tests such as these within the same sample.

3.2.1. Correlation

The first method is the most common in selection and consists of grouping both sets of variables in pairs, where a series of canonical correlation analyses demonstrate that the technology operational practices sets are congruent with the MS operational ones.

3.2.2. Regression

This is done by using a more general approach to the selection view, consistent with the congruency definition, where the groups of the dimensions of the two MPs are related in a multidimensional configuration subordinated by bivariate analysis, in order to observe whether they follow a congruent pattern. In other words, one dimension at a time of either MP is taken with all dimensions at the same time of the other MP in a multiple regression. Then, the opposite is also done, by switching the MPs positions in the regression equation as seen below.

Multiple linear regression was used to test these hypotheses. In line with Umanath and Kim's (1992) and Umanath's (2003) conclusions on congruency, we tested the hypothesis using the equations [1] y [2], where T represents Technology and S, Manufacturing Strategy. The S and T sub indexes 1, 2, and 3 represent the three respective dimensions of the two manufacturing practices (MP) (Table 1), the βs are the fit coefficients associated with their respective variables, i=1-3 represents the three dimensions both for S and for T and ε is the error.

$$\mathbf{T_i = \beta_0 + \beta_1 S_1 + \beta_2 S_2 + \beta_3 S_3 + \varepsilon_i} \qquad [1]$$

$$\mathbf{S_i = \beta_0 + \beta_1 T_1 + \beta_2 T_2 + \beta_3 T_3 + \varepsilon_i} \qquad [2]$$

The congruency perspective is supported by the statistical significance of β associated with the interest variable.

Table 1. Manufacturing Strategy and Technology Dimensions

Dimension	**Variable**
Anticipation of new technologies	S1
Formal strategic planning	S2
Manufacturing Strategy-Business Strategy Link	S3
Effective process implementation	T1
Interfunctional design efforts	T2
Supplier involvement	T3

4. DATA COLLECTION METHODS

This paper is part of High Performance Manufacturing (HPM), an international research project, based on a dynamic and broad theoretical model. As an international empirical project, it now involves 70 researchers from 14 research groups, which are part of 28 Universities in 14 countries from America, Asia and Europe.

With regard to the sample, the analytical unit used is the individual manufacturing plant, not the company, as there may be significant differences from plant to plant with regard to practices, performance and contextual factors, even within the same company. It was also established that the plants should have a minimum workforce of 100 workers, as some of the practices analysed were not applicable to small plants. The worldwide sample was therefore made up of about 270 plants in ten countries: Germany, Austria, Canada, Korea, USA, Spain, Finland, Italy, Japan and Sweden. The chosen plants in each country were taken from three different industries: auto supplier, electronics and machinery. Using the international auto supplier sector, the data required for our study was analysed by comparing plants.

Thus, this research uses the HPM survey as the basic tool for obtaining data. Twelve questionnaires were used aimed at twelve different positions in each of the plants, from plant manager down to the supervisors and shop floor workers, covering all the scales and measures for all the manufacturing practices/initiatives in hundreds of different items. Through the questionnaires, a substantial amount of objective data relating to performance and the features of the plant was also gathered along with a range of exogenous variables. However, the information required to analyse the data in this research focuses solely on Manufacturing Strategy and Technology. Many of the scales are included in at least two different questionnaires so that information can be triangulated for a greater degree of reliability.

The items and scales used as measuring instruments were developed from an extensive review of relevant literature on manufacturing processes as part of the HPM project. Panels of experts examined these items and scales to ensure the validity of the content. Afterwards, pre-tests were piloted in some plants, which were later excluded from the collection rounds. They have also been subjected to an analysis for their reliability, validity and internal consistency. Reaffirming the robustness of the values, on the scales used, as far as construction validity, nomological validity and internal consistency have, the questionnaires have also been reviewed on the two previous rounds (e.g., Flynn, et al., 1995).

All data used here objective are perceptual scales. For this reason, the reliability and validity of manufacturing strategy and technology practices sets were checked for the data analysis in such a way that the items loaded on a second factor or scale were eliminated. As a result, the following scales were withdrawn: "communication of manufacturing strategy" (initially proposed as part of the set of manufacturing strategy) and "simplicity of product design" (initially proposed as part of the set of technology), because their items did not meet the required prerequisites in their measures. A reliability analysis was conducted at the plant level for each scale to evaluate internal consistency. Reliability was measured by Cronbach's alpha. Following Nunnally (1967), we used a score of 0.6 or more as a criterion for a reliable scale. All scales finally used in the analysis exceeded this criterion level.

5. EMPIRICAL RESULTS

This section deals with the relationships among two practices set, one from technology (T) and another from manufacturing strategy (MS). All three hypotheses are tested here, hypothesis 1 through canonical correlation analysis and hypotheses 2 and 3 through regression. This last method is also used to confirm hypothesis 1.

5.1 Correlation

The statistical analysis regarding the selective fit between MS and technology practices sets through the association of canonical correlation between these variables allows for the deduction of the combinations than described the following results on table 2.

Table 2. MS and T correlations

	First canonical variable
Canonical Correlation	0.90587
Likelihood ratio	0.38030
Signifcance	0.00000
Redundancy index	0.42750
Correlations between manufacturing strategy and canonical variables of technology related practices	
Anticipation of New Technologies	0.53111
Formal Strategic Planning	0.27929
Manufacturing - Business Strategy Linkage	0.36309
Redundancy index	0.43610
Correlations between technology-related scales and canonical variables of MS related practices	
Effective Process Implementation	0.90587
Interfunctional Design Efforts	0.02289
Supplier Involvement	0.26368
Redundancy index	0.31172

Table 2 shows the results of a canonical correlation analysis between three operation practices related to technology and other three operations practices related to manufacturing strategy, representing main operations management areas. A pair of the first canonical correlation variables gives clear evidence that MS practice set has a strong impact on T practice set. The canonical correlation is very close to 0.91 and is highly significant. The redundancy index shows that close to half of the variance in T practice set is explained by the first canonical variables of MS related practices and that some one-third of the variance in MS practice set is explained by the first canonical variables of T related practices. Effective process implementation show the highest correlation with the first canonical variable of MS related practices, while anticipation of new technologies takes the most important position to account for first canonical variable of T related practices.

These results for international auto supplier manufacturing plants support hypothesis 1 that there is a congruency displayed through a bidirectional relationship between Manufacturing Strategy and Technology. The successes of manufacturing industries may often be attributed to their unique practices related to MS and T production without special attention to their link. Our results reveal that technology related practices must be accompanied by sophisticated by MS related practices, which should be a more important reason why some manufacturing companies achieve a desirable effectiveness level in the global marketplace.

5.2 Regression

Fit has been widely measured through the main effect of regression coefficients in the selection perspective (see Hair et al., 1998). Regression analysis not only shows the general direction of the association, but also provides the degree to which the independent variables affect the dependent variable. The main effect of multiple regression allows the importance and the interrelationship between a number of dimensions of a manufacturing practice (MP) to be explored as independent variables with one variable of the other MP as the dependent variable. We have thus used multiple regression to test the specific hypotheses, 1 - 3, in three stages. The first two of these focused on hypotheses 2 and 3, respectively. Each stage used three regression models, each of which included a scale of one of the MPs as a dependent variable and the three scales of the other MP as independent variables. The third stage dealt with hypothesis 1 and derived from the other two.

All the results obtained were significant and are set out in Tables 3 and 4. For the first stage (equation 1), Table 3 shows the results for the first three models, where the columns represent the technology dimensions that were tested to see whether there might be any influence from the manufacturing strategy dimensions (rows).

Table 3. Influence of Manufacturing Strategy on Technology

		Technology		
		Eff. Proc. Imp. (T_1)	***Int. Des. Eff. (T_2)***	***Supp. Involv. (T_3)***
Manufacturing. Strategy	**Anticipation of new technologies. (S1)**	***0.2953******	***0.2742******	*0.2398*
	Formal Strategic Planning (S_2)	**0.1857***	0.0968	0.2941
	Manuf. Strat.-Bus. Strat. Link (S_3)	**0.2833****	**0.3244****	0.1831
	F	31.3238***	8.4121***	3.5101***
	R^2	0.5251	0.2289	0.1231
	R^2 corrected	0.5083	0.2017	0.0880

* $P \leq 0.1$; **$P \leq 0.05$; *** $P \leq 0.01$

The *effective process implementation* (T1) column shows that this is significantly related to all the manufacturing strategy dimensions (at different significance levels of 0.01, 0.05 and 0.1) In the next column, only *formal strategic planning* (S2) is not significantly related to the *interfunctional design effort* (T2), probably due to some type of restriction caused by planning. Finally, *supplier involvement* (T3) does not seem to be significantly related to any of the manufacturing strategy dimensions, possibly due to the fact that it is something that the company cannot completely control (contextual factor from suppliers). It can all be summarised as follows:

Table 3 measures MS effect on T through equation 1**.**This table shows that 5 out of 9 β coefficients are significant as follows:

- MS (all its 3 S's) influences T1
- MS (all but S2) affects T2
- MS does not influences T3

Thus, the following possible unidirectional congruency relationships are therefore obtained:

1. Manufacturing strategy ➔ effective process implementation

2. Manufacturing strategy ➔ interfunctional design effort

It can therefore be said that manufacturing strategy influences technology on an aggregate level and that as a result, hypothesis 2 has been fulfilled.

Table 4 sets out the results of the second stage (equation 2) with the three last models, the columns represent the manufacturing strategy dimensions that were tested to see whether there might be any influence from the technology dimensions (rows).

Table 4. Influence of Technology on Manufacturing Strategy

		Manufacturing Strategy		
		Anticipation of New Technologies. (S1)	**Formal Strategic Planning** (S2)	**Manuf. Strat.-Bus. Strat. Link** (S3)
Technology	**Eff. Proc. Imp. (T1)**	**0.6569******	**0.7940******	**0.6596******
	Int. Des. Eff. (T2)	0.0794	**-0.2063***	-0.0297
	Supp. Involv. (T3)	0.0816	**0.1568*****	**0.1029*****
	F	16.8439***	18.8423***	19.7408***
	R^2	0.4025	0.4298	0.4412
	R^2 corrected	0.3786	0.4070	0.4189

* $P \leq 0.1$; $^{**}P \leq 0.05$; *** $P \leq 0.01$

The three technology dimensions are significantly related to *formal strategic planning,* S2 (at different significance levels of 0.01, 0.05 and 0.1). Only *effective process implementation* (T1) is related to the *anticipation of new technologies* (S1) with a 0.01 significance level. Finally, it can be seen that all the technology dimensions except for *interfunctional design effort* (T2) are significantly related to the *manufacturing strategy and business strategy link,* S3 ($p \leq 0.01$ and $p \leq 0.05$), possibly due to manufacturing strategy being somewhat rigid.

Thus, the T effect on MS through the equation 2 is seen in Table 4. We can add from it that 6 out of 9 β coefficients are significant:

- T (all its 3 T's) affects S2

- T (all but T2) influences S3
- T1 affects S1

Therefore, the unidirectional relationships can therefore be summarised as follows:

1. Effective process implementation ➔ anticipation of new technologies.
2. Technology ➔ formal strategic planning
3. Technology ➔ manufacturing strategy-business strategy Link

It can therefore be stated that technology influences manufacturing strategy, thus confirming hypothesis 3.

To sum it all up, Table 5 shows all results using arrows, which points significant relationship directions. Hence, it seems that T affects MS a little more than the other way around, since there is one more significant relationship shown from Table 4 than from Table 3 (more arrows pointing to such direction in Table 5). In view of the foregoing results and regardless that the congruency does not seem total, we could conclude with some reservations that hypothesis 1 is also proved in general terms, i.e. that there is a bidirectional fit and a somewhat degree of congruency between both MPs. These results support the fact that both MPs mutually impact upon each other. However, it can be seen that the regressions shows greater detail of information on the multidimensional directions of the relationship.

Table 5. MS-Technology Congruency

	S1	S2	S3
T1	⏎⮥	⏎⮥	⏎⮥
T2	⏎	⮥	⏎
T3	⊗	⮥	⮥

6. CONCLUSIONS AND FUTURE RESEARCH

A proposal was made to test whether an interconnection existed between a set of manufacturing strategy practices set and a technology set with the selection perspective, without the causal direction or its effect on performance being measured. The results obtained demonstrated a somewhat degree of congruency fit, which means that both production practices are in a state of mutual fit or adjustment. In other words, it may be more advantageous for plants to implement them together: integrated with each other.

Bearing the foregoing in mind, we can say that the congruency (selection) model has demonstrated that there is some degree of association between technology and MS practices sets. Thus, if both MPs are not implemented, it could make it harder for plants in competitive environments (Drazin and Van de Ven, 1985). In other words, different levels of manufacturing strategy require different levels of technology, and vice-versa, if the plant wants to be more competitive. This was confirmed by using both canonical correlation analysis and multiple regression analysis.

It might be added that, in general terms, the use of an alternative method to correlation for the selection perspective has provided much more detail information, since the regression analysis method shows multidimensional directions between both scales clusters. The use of a confirmatory method not only corroborated results of the previous one, but it also throw light about details the other model could not show. Thus, it was possible to make a more complete evaluation of the link between both manufacturing practices sets. If only one of either model were applied, we might have simply gotten a partial view of the interaction. Hence, another main purpose of this research was to share this sort of methodology with POM researchers in what could be an important finding for obtaining a more complete view of the interaction between any two manufacturing practices sets by complementing two different methods of selection fit.

Finally we would like to highlight the fact that, when there is a somewhat high degree of congruency, as is the case of the fit found between manufacturing strategy and technology practices sets, this does not necessarily mean that variations in performance do not exist in reality. The crucial issue is that there are no ways of predicting these variations because the congruency theory implicitly assumes that only the best companies will survive and that the others will eventually be replaced (or that there will be mergers that will create better companies).

In the managerial world, this empirical research has relevance for all plants interested in adhering to manufacturing concepts related to the successful outcome of link between both practices in question for continuous improvement. It may show managers whether these practices are important in achieving competitive advantages, as well as their positive effects on the links between these same practices—aspects that are not sufficiently clear at the moment.

From a practical and concrete point of view, the auto suppliers plants will be able to understand more about the details of this kind of interrelationship in their sector, and if they should apply these manufacturing practices, and how to do it, to all of their plants. There still is room to test if this type of relationship between both MPs is seen in other sectors with very different characteristics.

The selection model used here imposes a linear correspondence between manufacturing strategy and technology practices sets and it incorporates an implicit single result measure (survival), without taking into account a direct result of the link with performance. This fit form—primarily of linear correspondence—does not take into account more complex relationships, for example a curvilinear relationship that could allow proof of the existence of two allowed values of one of the variables (manufacturing strategy or technology) for a single value of the other one.

However, this limitation may be overcome by future research that may extend this study from another perspective such as the interaction perspective in order to outline hypotheses regarding the dependencies between the fit of both manufacturing practices and performance. This allows for the question of whether improved operational performance may result from the interaction between manufacturing strategy and technology to be explored. Additionally, the interaction test allows the confirmation of the existence of curvilinear relationships.

Acknowledgments

The present work is part of the projects of the National Program of Industrial Design of the Ministry of Education and Science of Spain (DPI-2006-05531) and Excellence Projects of the PAIDI (Plan Andaluz de Investigación, Desarrollo e Innovación de la Junta de Andalucía-Spain).

REFERENCES

Bates, K, Blackmon, K., Flynn, E., C. Voss. 2001. Manufacturing Strategy: Building Capability for Dynamic Markets. In: Schroeder, R., Flynn, B., (Eds.). High Performance Manufacturing-Global Perspectives, New York: John Wiley & Sons, Inc., 42-72.

Bates, K., Amundson, S., Schroeder, R., W. Morris. 1995. The Crucial Interrelationship between Manufacturing Strategy and Organisational Culture. Management Science, 41 (10), 1565-80.

Berry, W.D. 1984. Nonrecursive causal models. Newbury Park: Sage.

Cronbach, L. J. 1951. Coefficient alpha and the internal structure of tests. Psychometrika, 16, 297-334.

Drazin, R., A. H. Van de Ven. 1985. Alternative forms of fit in contingency theory. Administrative Science Quarterly, 30, 514-39.

Ford, D. 1980. Develop Your Technology Strategy. Long-Range Planning, 21, 85–95.

Gerdin, J., J. Greve. 2004. Forms of contingency fit in management accounting research—a critical review. Accounting, Organizations and Society, 29, 303–26.

Hair, J. F., Anderson, R.E., Tatham, R.L., W. C. Black. 1998. Multivariate Data Analysis. Upper Saddle River, New Jersey: Prentice-Hall.

Ketokivi, M., R. G. Schroeder. 2004. Manufacturing practices, strategic fit and performance. A routine-based view. International Journal of Operations & Production Management, 24 (2), 171-91.

Maidique, M. A., B. J. Patch. 1988. Corporate Strategy and Technology Policy. In: Tushman, M.L., Moore, W.L., (Eds.). Readings in Management of Innovation (2nd Ed.). Cambridge, MA: Ballinger, 236–248.

Matsui, Y. 2002. Contribution of manufacturing departments to technology development: An empirical analysis for machinery, electrical and electronics, and automobile plants in Japan. International Journal of Production Economics, 80, 185–97.

McKone, K. E., R. G. Schroeder. 2002. A plant's technology emphasis and approach. A contextual view. International Journal of Operations & Production Management, 22 (7), 772-92.

Morita, M., E.J. Flynn. 1997. The Linking among Management Systems, Practices and Behavior in Successful Manufacturing Strategy. International Journal of Operations and Management, 17 (10), 967-93.

Nunnally J.C. 1967. Psychometric Theory, New York: McGraw-Hill.

Parker, A. 2000. Impact on the Organisational Performance of the Strategy-Technology Policy. Interaction. Journal of Business Research, 47, 55–64.

Parthasarthy, R., S. Sethi. 1993. Relating strategy and structure to flexible automation: a test of fit and performance implications. Strategic Management Journal, 14, 529–49.

Primrose, P.L. 1992. Evaluating the introduction of JIT. International Journal of Production Economics, 27, 9–22.

Schroeder, R. G., B. Flynn. (Eds). 2001. High Performance Manufacturing-Global Perspectives. New York: John Wiley & Sons, Inc.

Umanath, N. 2003. The concept of contingency beyond ''It depends'': illustrations from IS research stream. Information & Management, 40, 551–62.

Umanath, N., K. Kim. 1992. Task-Structure Relationship of Information Systems Development Subunit: A Congruence perspective. Decision Sciences, 23 (4), 819-38.