INNOVATIVE CAPABILITIES, OPERATIONS PRIORITIES AND CORPORATE PERFORMANCE IN MANUFACTURING FIRMS

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ABSTRACT

The purpose of this paper is to explore the linkage between innovative capabilities and operations priorities and corporate performance and try to answer the question of how innovative capabilities support a manufacturing firm's operations priorities and corporate performance. By using survey data from 184 manufacturing firms, firms are clustered according to their innovative capabilities. These clusters are explored in terms of operations priorities and corporate performance. The findings substantiate that manufacturing firms can be clustered according to their innovative capabilities. Each innovation cluster adopts and develops different operations priorities and they attain diverse financial performance levels implying that there are alternative ways to compete in the market even within the same industry. However, each alternative strategy provides diverse levels of benefits. The findings demonstrate further that high performing firms compete effectively on multiple operations priorities simultaneously. Hence, firms need to excel in multiple priorities and innovation types in their market.

Keywords Innovative Capabilities, Operations Priorities, Corporate Performance, Manufacturing Firms, Cluster Analysis.

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1. INTRODUCTION

Innovativeness is one of the fundamental instruments of firms' business strategies to increase the existing market share, to enter new markets, to gain reputation in customers' perception and to create competitive advantage. In the last decades, the importance of innovation is largely enhanced and it has become an important contributor to competitive success, since added value of existing products and services are diminishing as a result of rapidly changing technologies and extreme global competition. This process has caused an even greater interest on improving products, services and processes for which innovations are indispensable.

The main objective in this paper is to explore the linkage between innovative capabilities and operations priorities and corporate performance. The question of how innovative capabilities support a manufacturing firm's operations priorities and corporate performance will be attempted to be answered.

A framework for the analysis of innovative capabilities will be presented. The study is based on empirical methodology and data analysis covering 184 manufacturing firms in the Northern Marmara Region in Turkey. These firms will be grouped into clusters according to their innovative capabilities and these clusters will be explored in terms of their operations priorities and corporate performance dimensions.

The outline of this study is to:

i. Develop a taxonomy of innovative capabilities for manufacturing firms based on their product, process, marketing and organizational innovative capabilities.

ii. Discover what different operations priorities are employed by different innovation clusters for competing in the market place.

iii. Investigate the differences in corporate performance among the innovation clusters.

This study contributes to the innovation management literature by identifying innovation clusters in the manufacturing industry in an emerging country, since studies using taxonomies to illustrate the strategic importance of innovations for competitiveness are very limited. Innovations taxonomy provides an influential means of describing how innovative capabilities align with operations priorities to improve corporate performance in a competitive business environment.

This paper has six sections. In the second section, succeeding the Introduction section, the research propositions are presented. Third section describes the methodology and the analyses. The results are introduced in the forth section. Discussion and concluding remarks follow in the fifth section.

2. RESEARCH PROPOSITIONS

This study maintains that manufacturing firms adopt different innovative capabilities, and these diverse capabilities imply different sets of operations priorities. Besides, we also want to examine whether the corporate performance of these firms can be differentiated by their choice of innovative capabilities. Therefore, the following three propositions are made:

P_1. Firms can be grouped into different innovation clusters based on their capabilities on the product, process, marketing and organizational innovations.

P_2. Different innovation clusters adopt different operations priorities.

P_3.Different innovation clusters achieve different corporate performance levels (financial, innovative, production, market).

Business researchers acknowledge operations strategies and operations priorities among the most attractive subject areas of operations management, since these subjects are among the crucial factors of corporate performance and of strategic planning processes of an enterprise (Sum et al., 2004; Boyer and Lewis, 2002; Malhotra et al., 1994; Hayes et al., 1988). Here we adopt as operations priorities cost, quality, flexibility and delivery/dependability, which have become widely used as statements of the competitive dimensions of manufacturing (Voss, 1995). In the questionnaire, these operations priorities are further subdivided into their relevant components. Operations strategies can be defined as the relative weighting of the operations priorities. Firms aim to gain additional competitive advantage and to achieve increased business performance through the implementation of operations strategies, which need to be in proper alignment with the properties of the competitive environment the firm is in. Several researchers have examined the links between operations/manufacturing strategies and corporate performance (Corbett and Campbell-Hunt, 2002). Based on an empirical study, Noble (1997) demonstrated that manufacturing strategies of high-performing firms are unlike low-performing firms. Remarkably, their findings support that better performing firms are more probable to concentrate on multiple capabilities concurrently and are more likely also to possess more clearly defined competitive strategies.

Corporate performance is considered here in four different components: Financial, innovative, production and market performances. Several researchers have attempted to represent explicitly the positive impact of innovations on corporate performance. Experience gained indicates that one needs to go beyond financial performance when trying to assess corporate performance, since certain thriving innovative managerial efforts cannot be measurable with financial performance indicators such as Return on Sales, Return on Investments and Return on Assets (Zahra, 1993). An attempt to measure the payback of innovations is presented by Andrew and Sirkin (2006). McAdam and Keogh (2004) investigated the relationship between firms' performance and its familiarity with innovation and research. They found that firms' tendency to innovations are vital in the sense of installing the connection between innovativeness and competitiveness. Zahra and Sidhartha (1993) reached the conclusion that innovation strategy is an important major predictor of financial performance. Gunday et al. (2008) reported based on an empirical study that innovative firms are rewarded by higher corporate performance including financial performance.

3. METHODOLOGY

3.1. Data Collection

A questionnaire consisting of 311 individual questions was developed to be filled in by the upper managers of manufacturing companies. The questionnaire is designed to assess a firm's business strategy, innovativeness efforts, competitive priorities, market and technology strategy, in-firm environment, market conditions and corporate performance. The initial survey draft was discussed with firms' executives and it was pre-tested by 10 pilot interviews to ensure that the wording, format and sequencing of questions are appropriate.

Data was collected over a 7-month period in 2006-2007 using a self-administered questionnaire distributed to firms' upper level managers operating in six different manufacturing sectors (textile, chemical, metal products, machinery, domestic appliances and automotive industries) in the Northern Marmara region in Turkey. These industries were selected to represent the major manufacturing sectors in an emerging country such as Turkey.

Because of the diversity of the organizational structures, where corporate strategies are developed, a manufacturing business unit was selected as the unit of analysis.

A total of 1674 firms were selected randomly, where the number of firms selected from each sector and province covered in the study is representative of the number of firms in that sector and province. Randomly selected face-to-face interviews were arranged concurrently with the mail application. The dispersion of the firms to the sectors and control variables such as firm size were considered in order to obtain a true randomized and representative sample when arranging for interview appointments. From 120 invitations extended, a total of 101 interviews were performed. Together with the responses from the mail survey, we obtained 184 usable questionnaires resulting in a response rate of 11%. All the respondents completing the questionnaire were from the top (52%) or middle management (48%).

The degree by how much the sample consisting of 184 firms is representative of the population is addressed by carrying out a series of comparative tests regarding firm distributions according to sectors. For each sector, number of firms in the sample turned out to be representative, since no significant difference has been detected between the population and sample percentages.

Moreover the data is also controlled with *t*-test procedure for non-respondent bias (randomness of the data) and there is no significant difference ($p \leq 0.05$) between the interview and mailing data sets responses both in terms of the questionnaire items and constructs, i.e. innovation and firm performance variables as well as in terms of control variables. In the analyses, variables such as firm size, firm age, ownership status and foreign investments in the company are examined as control variables, since these organizational variables may have possible effects both on innovative capabilities and firm performance.

In ***Figure 1*** the profile of the resulting sample is displayed illustrating its diversity in terms of firm size, firm age and annual sales volume. Firm size is determined by the number of full-time employees (up to 50: small, $50 \leq$medium <250, ≥ 250: large) and firm age is determined by the year production had started (up to 1975: old, $1975 \leq$moderate<1992, ≥ 1992: young).

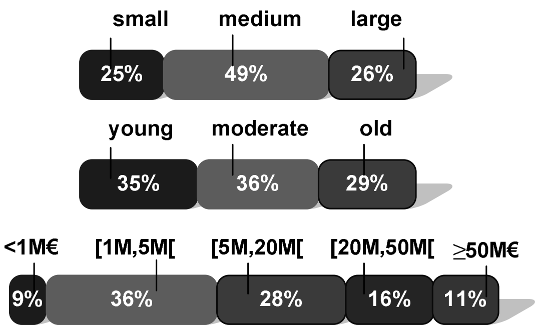

Figure 1: Sample profile

After the data collection stage, multivariate statistical analyses via SPSS v13 software package were conducted in order to validate the research framework. Occasional missing data were randomly distributed (MAR) on items and they were handled by list wise deletion.

3.2. Measurement of Variables

The questionnaire form is prepared by considering recent questionnaire forms utilized in similar studies, and commonly accepted measures met in the current literature.

Specifically, the questions about operations priorities are asked using a 5-point Likert scale and inquiring how important each operations priority is for the firm with the scale ranging from 1=extremely unimportant to 5= extremely important. Such subjective measures possibly bring in manager bias, but are widespread practice in researches (Khazanchi et al., 2007).

The scales of the four different operations priorities' measures are adapted from existing OM literature with six, six, seven, and six criteria, respectively. The base of items asked regarding these priorities are adapted mainly from Boyer and Lewis (2002), Alpkan et al. (2003), Noble (1997), Ward et al. (1998), Vickery et al. (1993) and Kathuria (2000).

The questions about innovative capabilities are asked employing a 5-point Likert scale. The respondents are asked to indicate "to what extent the innovations implemented in their organization in the last three years related to the following kinds of activities" ranging from 1= 'not implemented', 2= 'imitation from national markets', 3= 'imitation from international markets, 4= 'current products/processes are improved', 5= 'original products/processes are implemented'. The base of items asked regarding these capabilities is adapted mainly from Oslo Manual (OECD, 2005). Each innovation construct is measured by its original measurement items, which are developed accordingly. Therefore, innovation measures used in this research are new for the literature and hence need to be validated.

Four different performance measures are employed to expose the effects of realized innovations on firm performance. A scale consisting of seven criteria is adapted for innovative performance from Antoncic and Hisrich (2001), and Hagedoorn and Cloodt (2003). Production performance, market performance and financial performance scales are adapted from existing academic literature with four, three and four criteria, respectively. The base of items asked regarding these performance criteria are adapted mainly by researches of Barringer and Bluedorn (1999), Hornsby et al. (2002), Narver and Slater (1990) and Yılmaz et al. (2005).

The questions about firm performance try to reveal the managers' perception of the firm performance in the last 3 years compared to the previous years' performance. A 5-point Likert scale is used with the scale ranging from 1= extremely unsuccessful to 5= extremely successful. The reason behind using this subjective scale is that the firms are reluctant to disclose exact performance records, and the managers are less willing to share objective performance data (Boyer et al., 1997; Ward and Duray, 2000). Conversely, top managers, who are well-acquainted with performance data, can provide more precise subjective evaluations (Choi and Eboch, 1998). Moreover, objective measures can limit the comparability and accuracy of responses (Dess and Robinson, 1984; Porter, 1979).

4. ANALYSES AND RESULTS

The multivariate data analysis is performed in two stages, using statistical software packages SPSS v13. The first stage is about extracting the factor structure. Principal component analysis (PCA) is applied in order to reduce the larger set of variables into a more manageable set of scales, since the initial number of variables is too large to conduct an analysis of individual linkages (Flynn et al., 1990; Benson et al., 1991; Saraph et al., 1989).

PCA with varimax rotation is conducted to find out the underlying dimensions of innovations, operations priorities and corporate performance items. The title for each factor is selected to represent the included variables as closely as possible. This stage is concluded by exploring internal consistency and reliability (content validity) among the items of each construct via Cronbach α (Carmines and Zeller, 1979). Cronbach α values ≥ 0.7 suggest a satisfactory level of construct reliability (Nunnally, 1978; Streiner, 2003). Moreover, convergent validity between the innovation constructs is also examined and verified by the average-variance extracted (AVE) test, with its value being equal to the square root of average communalities of items on that factor (Fornell and Larker, 1981). A compelling demonstration of convergent validity would be an AVE score of 0.5 or above. The second stage is about the cluster analysis of firms according to 4 innovative capabilities (product, process, marketing and organizational innovations). Then, the resulting innovation clusters are compared with each other regarding operations priorities and corporate performance using ANOVA and post-hoc tests.

4.1. Stage 1: Factor Structures

For the PCA of innovative capabilities (there are 24 variables), Bartlett's Test is conducted to assess the overall significance of the correlation matrix. As a result, the chi-square score is 2188.3 with 276 degrees of freedom and the p-value is <0.01. Therefore we reject the null hypothesis that variables are uncorrelated in the population.

The KMO score is 0.902, which validates that correlation matrix is appropriate. The PCA on innovations extracted 5 factors with eigenvalues > 1 (***Table 1***). Moreover none of the items are eliminated since each communality is over 0.5. Based on the items, these five factors are respectively labeled. The total variance explained is 63.741%. The Cronbach α values are ≥ 0.7 suggesting construct reliability. In our case, the smallest AVE score is found as $0.774 \geq 0.5$.

Similarly, for the PCA of operations priorities (there are 25 variables), Bartlett's test is conducted to assess the overall significance of the correlation matrix. As a result, the chi-square score is 1557.1 with 190 degrees of freedom and $p<0.01$. Therefore we reject the null hypothesis that variables are uncorrelated in the population. Next, the KMO score is 0.838, which also validates that the correlation matrix is appropriate (***Table 2***). After omitting five variables whose communalities are below 0.5, PCA produced 4 factors with latent root criterion and the average of communalities was 0.601. To validate the factors, we look at the AVE tests and Cronbach α values. Here, the smallest AVE score for the underlying factors is 0.750 and Cronbach α values range from 0.843 to 0.770, suggesting satisfactory levels of construct reliability.

Table 1: PCA of innovative capabilities

Factors	Factor Loads	Eigen-value	Cum. % variance explained	Cronbach α	AVE
Factor 1: Organizational Innovations		9.027	37.613	0.896	0.783
Renewing the organization structure to facilitate teamwork	0.763				
Renewing the organization structure to facilitate coordination between different functions such as marketing and manufacturing	0.736				
Renewing the organization structure to facilitate project type organization	0.736				
Renewing the routines, procedures and processes employed to execute firm activities in innovative manner.	0.711				
Renewing the human resources management system.	0.679				
Renewing the production and quality management system.	0.685				
Renewing the supply chain management system.	0.629				
Renewing the organizational structure to facilitate strategic partnerships and long-term business collaborations	0.501				
Renewing the in-firm management information system and information sharing practice	0.494				
Factor 2: Marketing Innovations		2.181	46.700	0.835	0.785
Renewing the distribution channels without changing the logistics processes related to the delivery of the product	0.720				
Renewing the product pricing techniques employed for the pricing of the current and/or new products	0.709				
Renewing the product promotion techniques employed for the promotion of the current and/or new products	0.700				
Renewing the design of the current and/or new products through changes such as in appearance, packaging, shape and volume without changing their basic technical and functional features	0.638				
Renewing general marketing management activities.	0.632				
Factor 3: Process Innovations		1.803	54.214	0.820	0.830
Determining and eliminating non value adding activities in delivery related processes	0.713				
Decreasing variable cost and/or increasing delivery speed in delivery related logistics processes	0.681				
Decreasing variable cost components in manufacturing processes, techniques, machinery and software.	0.675				
Determining and eliminating non-value adding activities in production processes	0.648				
Increasing output quality in manufacturing processes, techniques, machinery and software	0.634				
Factor 4: Incremental Product Innovations		1.251	59.426	0.701	0.774
Introducing innovations in components and materials of current products to increase product quality	0.666				
Introducing innovations in current products leading to improved ease of use and improved customer satisfaction	0.658				
Introducing innovations in components and materials of current products to decrease product cost	0.656				
Factor 5: Radical Product Innovations		1.036	63.741	0.799	0.854
Developing new products with technical specifications and functionalities totally different from the current ones	0.800				
Developing new products with components and materials totally different from the current ones	0.714				
KMO Measure of Sampling Adequacy = 0.902; Bartlett Test of Sphericity = 2188.3; $p<.000$.					

Table 2: PCA of operations priorities

Factors	Factor Loads	Eigen-value	Cum. % variance explained	Cronbach α	AVE
Factor 1: Cost		6.423	32.114	0.843	0.750
Decrease in total cost of manufacturing processes	0.763				
Decrease in total cost of internal and external logistics processes	0.738				
Decrease in operating costs	0.728				
Increase in personnel productivity	0.686				
Decrease in input costs	0.644				
Decrease in waste and scrap	0.579				
Decrease in defective intermediate and end products	0.558				
Factor 2: Dependability/Delivery		2.454	44.385	0.823	0.805
Increase in delivery speed of products	0.788				
Decrease the makespan from start of manufacturing process to the completion of delivery	0.744				
Increase in ability to meet the delivery commitments	0.718				
Decrease the makespan from taking the orders to the completion of delivery	0.707				
Increase in just in time delivery	0.631				
Factor 3: Flexibility		1.708	52.927	0.796	0.759
Increase in ability of flexible use of current personnel and hardware for non-standard products	0.826				
Increase in ability of producing non-standard products	0.799				
Decrease in declining product orders with different specifications	0.720				
Ability to change machine and equipment priorities when necessary	0.657				
Increase in ability of flexible production	0.484				
Factor 4: Quality		1.426	60.058	0.770	0.806
Increase in product and service quality according to customers' perception	0.809				
Increase in product and service quality compared to rivals	0.782				
Decrease in customer complaints	0.725				
KMO Measure of Sampling Adequacy = 0.838; Bartlett Test of Sphericity = 1557.127; *p*<.000.					

Finally, in the Bartlett's test for PCA of corporate performance (there are 18 variables), the chi-square score is found as 1692.9 with 136 degrees of freedom and the p-value is <0.01. Therefore we reject the null hypothesis that the variables are uncorrelated in the population. The KMO score is 0.839, which validates that the correlation matrix is appropriate.

The PCA on corporate performance results in 4 factors with eigenvalues > 1 (***Table 3***). After omitting one variable ("Ability to introduce new products and services to the market before competitors"), whose communality is below 0.5, PCA results in 4 factors with eigenvalues > 1 and the average of communalities is 0.68. To validate the factors, AVE tests are employed and the Cronbach α values are checked. Here, the smallest AVE score for the underlying factors is 0.764 and the Cronbach α values range from 0.930 to 0.711, suggesting satisfactory levels of construct reliability.

Table 3: PCA of corporate performance

Factors	Factor Loads	Eigen-value	Cum. % variance explained	Cronbach α	AVE
Factor 1: Financial Performance		5.998	35.282	0.930	0.788
Return on assets (profit/total assets)	0.918				
General profitability of the firm	0.910				
Return on sales (profit/total sales)	0.893				
Cash flow excluding investments	0.777				
Factor 2: Innovative Performance		2.588	50.506	0.816	0.908
Renewing the administrative system and the mind set in line with firm's environment	0.755				
Innovations introduced for work processes and methods	0.736				
Quality of new products and services introduced	0.701				
Number of new product and service projects	0.657				
Percentage of new products in the existing product portfolio	0.651				
Number of innovations under intellectual property protection	0.562				
Factor 3: Production Performance		1.676	60.362	0.711	0.824
Production (volume) flexibility	0.729				
Production and delivery speed	0.697				
Production cost	0.677				
Conformance quality	0.661				
Factor 4: Market Performance		1.152	67.136	0.766	0.764
Total sales	0.729				
Market share	0.727				
Customer satisfaction	0.606				
KMO Measure of Sampling Adequacy = 0.839; Bartlett Test of Sphericity = 1692.874; p<.000					

4.2. Stage 2: Cluster Analysis

In this research, we perform cluster analysis to form innovation clusters grouping firms based on their innovative capabilities. For that purpose, SPSS v13 is employed using the squared Euclidian distance measure. A hierarchical procedure based on Ward's agglomerative method is used to process the data.

The elbow criterion was employed as a stopping rule (Hair et al., 2006) and the inspection of percentage change in clusters suggested a four-cluster solution. These four clusters were then examined according to their differences and for managerial interpretability. The ANOVA test is performed to test for differences across the clustering variables by group mean. The result showed that all the four-cluster solutions significantly differ at 5 percent level. ***Table 4*** presents the four innovation clusters. The clusters are named based on their relative performance in the innovative capability factors: Followers (82 firms), Inventors (35 firms), Leading Innovators (41 firms) and Laggers (22 firms). From here on, the cluster names will also designate the firms in these clusters

Table 4: Innovation clusters and their innovative capabilities

Innovative Capabilities	Leading Innovators (Cluster 1)	Followers (Cluster 2)	Inventors (Cluster 3)	Laggers (Cluster 4)	F (or K)
Incremental product innovations					
Cluster mean	3.80[a] (2,3,4)[b]	3.29 (1,4)	3.14 (1,4)	1.44 (1,2,3)	45.89[c] p<0.000
Radical product innovations					
Cluster mean	4.17 (2,3,4)	1.71 (1,3,4)	3.74 (1,2,4)	1.14 (1,2,3)	130.10[d] p<0.000
Process innovations					
Cluster mean	4.17 (2,3,4)	3.04 (1,3,4)	2.27 (1,2,4)	1.67 (1,2,3)	41.09[c] p<0.000
Marketing innovations					
Cluster mean	3.88 (2,3,4)	2.40 (1,4)	2.11 (1,4)	1.28 (1,2,3)	64.26[c] p<0.000
Organizational innovations					
Cluster mean	3.92 (2,3,4)	2.93 (1,3,4)	2.21 (1,2,4)	1.62 (1,2,3)	67.15[c] p<0.000

Notes: [a] Mean based on 5-point Likert scale comparing the last 3 years' innovativeness performance with the previous years' innovativeness performance. [b] Numbers in parentheses indicate the cluster groups from which this cluster is significantly different at α=0.05 according to the Bonferroni, post-hoc pairwise comparison procedures. [c] F and corresponding p-values based on ANOVA test. [d] Radical product innovation test statistic is based on Kruskal Wallis test.
Underlined values indicate significance at α=0.01.

Table 5: Innovation clusters and their operations priorities

Operations Priorities	Leading Innovators (Cluster 1)	Followers (Cluster 2)	Inventors (Cluster 3)	Laggers (Cluster 4)	F (or K)
Cost					
Cluster mean	4.50[a]	4.40	4.30	4.18	1.96[c] p<0.121
Quality					
Cluster mean	4.80 (3,4)[b]	4.69	4.55 (1)	4.53 (1)	3.14[d] p<0.042
Flexibility					
Cluster mean	4.01 (2,4)	3.61 (1)	3.87	3.55 (1)	3.67[c] p<0.013
Delivery					
Cluster mean	4.55 (2)	4.29 (1)	4.30	4.29	2.18[c] p<0.092

Notes: [a] Mean based on 5-point Likert scale comparing the last 3 years' operations performance with the previous years' operations performance. [b] Numbers in parentheses indicate the cluster groups from which this cluster is significantly different at α=0.1 according to the Bonferroni, post-hoc pairwise comparison procedures. [c] F and corresponding p-values based on ANOVA test. [d] Quality test statistic is based on Kruskal Wallis test.
Underlined values indicate significance at α=0.1.

After firms are clustered based on their innovative capabilities, resulting clusters are compared regarding the operations priorities and corporate performance (***Table 4*** and ***5***, respectively). These comparisons involve ANOVA test with Benforroni post-hoc pairwise comparison test aiming to clarify which groups significantly differ with each other in terms of their priorities and firm performance. This will thereby help to verify our research propositions. Analysis of variance is used for examining the differences in the mean values of the independent variable associated with the effect of the controlled independent variables after taking into account the influence of the uncontrolled independent variables.

4.2.1. Cluster analysis of innovative capabilities

The results indicate that all four-cluster solutions significantly differ at 5 percent level ($p<0.01$). The presence of four distinct innovation clusters supports P_1 that firms can be grouped into different innovation clusters based on their capabilities on the product, process, marketing, and organizational innovations.

4.2.2. Cluster analysis of operations priorities

The question is whether different innovation clusters adopt different operations priorities and whether the level of importance given to an operations priority depends on in which innovation cluster that firm is? Thus, the null hypothesis is that the mean scores for the operations priorities of the clusters are equal. ***Table 5*** indicates the operations priorities of innovation clusters. The significant difference in operation priorities of four distinct innovation clusters supports P_2 that different innovation clusters adopt different operations priorities.

Figure 2 displays the box plots of operations priorities factors (cost, quality, flexibility, delivery in that order) according to innovation clusters. The vertical axes represent the 95% confidence intervals of operations priorities scale and the horizontal axes signify the clusters of Leading Innovators, Followers, Inventors, and Laggers, respectively. The little circles on the boxplots represent the cluster mean. The boxplots reveal the importance of innovative capabilities for operations priorities, since more innovative clusters have higher scores on operations priorities. However, there are two noteworthy facts to be underlined. First, the firms in the Inventors cluster emphasize flexibility more than the firms in the Followers cluster. Second, except the Leading Innovators cluster, remaining three clusters have no clear difference for delivery but display an increasing confidence interval when moving from the Followers to Laggers. The last observation concerning the increase in confidence intervals is true over the remanining operations priorities as well.

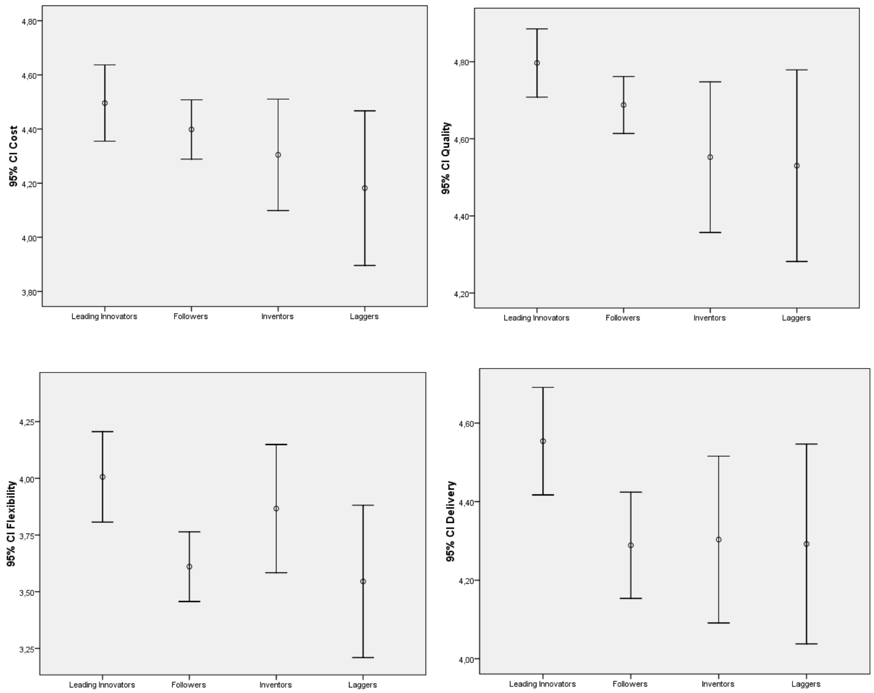

Figure 2: Boxplots of operations priorities

4.2.3. Cluster analysis of corporate performance

Finally, we examine the innovation clusters in terms of their corporate performance. The null hypothesis is that the mean scores of clusters for innovative, production, market and financial performances are equal (there are 4 separate ANOVA analyses here). Thus, it is tested whether innovation clusters also have different levels for different components of corporate performance or not. Rejection of this null hypothesis will imply that corporate performance of a firm depends to some extent on the level of its innovative capabilities. Note that, here, two additional independent variables based on objective data are introduced to complement the financial performance component. These are total sales (Million Euro-M€) and growth of total sales (%). These variables are tested by Kruskal-Wallis Test, since normality assumption and even the outlier analysis are irrelevant for these variables.

Table 6 indicates the performance factors of innovative clusters. The significant difference in innovative performance and slight differences in production, market performance, total sales and growth on total sales of innovation clusters supports P_3 that different innovation clusters achieve different operational and financial performance levels.

Table 6: Innovation clusters and their corporate performance

Corporate Performance	Leading Innovators (Cluster 1)	Followers (Cluster 2)	Inventors (Cluster 3)	Laggers (Cluster 4)	F (or K)
Innovative performance					
Cluster mean	3.96[a] (2,3,4)[b]	3.57 (1,4)	3.59 (1,4)	3.17 (1,2,3)	7.87[c] p<<u>0.000</u>
Production performance					
Cluster mean	4.01 (4)	3.85	3.91	3.51 (1)	2.18[c] p<<u>0.094</u>
Market performance					
Cluster mean	3.99 (4)	3.86	3.91	3.39 (1)	2.23[c] p<<u>0.087</u>
Financial performance					
Cluster mean	3.42	3.32	3.06	3.13	1.23[c] p<0.300
Total Sales					
Cluster mean	60.8 M€ (3,4)	26.8 M€	7.3 M€ (1)	13.0 M€ (1)	11.557[d] p<<u>0.009</u>
Growth of Total Sales					
Cluster mean	24.4%	22.4%	30.9%	12.5%	1.99[d] p<0.573

Notes: [a] Mean based on 5-point Likert scale comparing the last 3 years' operations performance with the previous years' operations performance.[b] Numbers in parentheses indicate the cluster groups from which this cluster is significantly different at α=0.1 according to the Bonferroni post-hoc pairwise comparison procedures. [c] F and corresponding p-values based on ANOVA test. [d] Total sales and growth of total sales test statistics are based on Kruskal Wallis test.
Underlined values indicate significance at α=0.1.

Figure 3 displays the box plots of corporate performance constructs (innovative, production, market and financial performance in that order) according to innovation clusters. The vertical axes represent the %95 confidence intervals of performance items' scale and horizontal axes signify the Leading Innovators, Followers, Inventors and Laggers, respectively. The boxplots confirm that higher innovativeness results in higher performance. For instance, for the market performance all three innovation clusters are significantly better than the Laggers cluster. The Followers cluster outperforms the Inventors cluster only in financial performance. Finally, the Leading Innovators cluster is again the dominant cluster with higher performance results. Similar to the operations priorities case, here as well the confidence interval increase when moving from the Followers to Laggers. Smaller confidence intervals imply more uniform performance among the firms within a cluster. It is interesting to note that, in general, the largest confidence intervals are observed for financial performance.

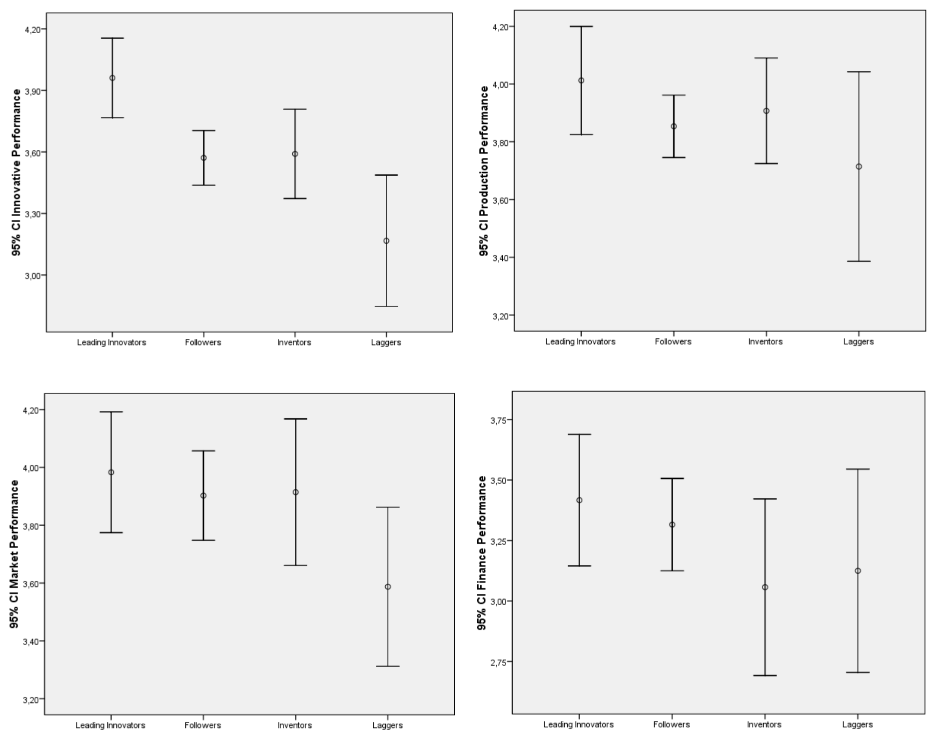

Figure 3: Boxplots of corporate performance factors

4.3. Innovation Clusters

4.3.1. Clusters and Industries

Figure 4 illustrates the distribution percentages of the innovation clusters into industries. It indicates that diverse clusters are present within the same and across sectors. Therefore, firm strategies are not industry-specific and diverse operation and innovative strategies can be adopted even in the same industry.

Among six industries, only in the domestic appliance sector the Laggers are not present. Furthermore, chemical industry has not only the highest portion of Leading Innovators, but also 18% of its firms are either in the Laggers or the Inventors clusters (the two least innovative clusters). Metal products, textile and machinery sectors have relatively more Laggers' firms than others. This can be explained by the fact that these three sectors employ relatively low technology.

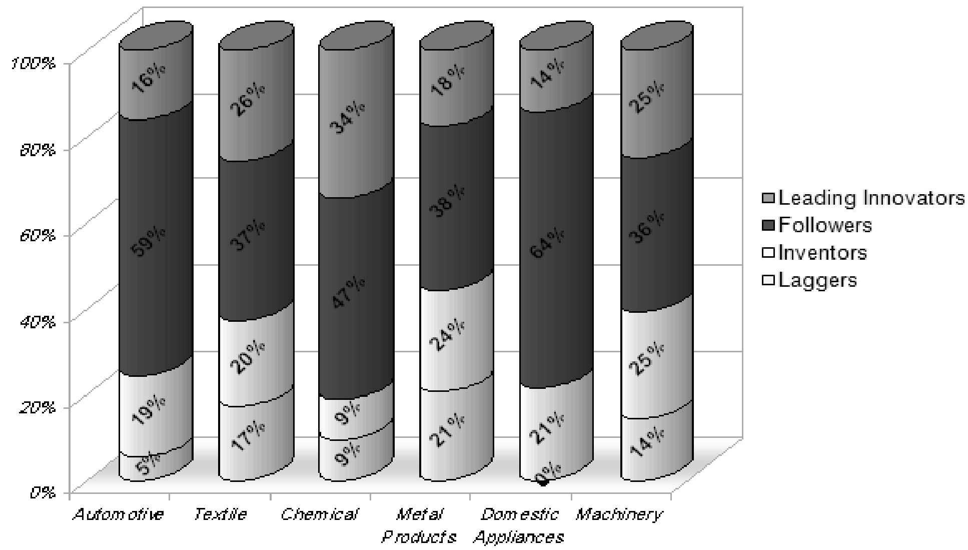

Figure 4: Clusters and industries

4.3.2. Leading Innovators

Leading Innovators outclassed other clusters in every aspect of innovative capabilities trying to nurture all innovation types, even the incremental product innovations, where their mean score is lowest (3.80). They have especially given higher importance to radical product and process innovations (Table 3).

Leading Innovators distinguish themselves in all categories of operations priorities. For all of these, their scores are the best among innovation clusters (Table 4). Furthermore, they appear to differ significantly in operations priorities factors as well: They are significantly better than Laggers in cost, quality and flexibility; significantly better than Followers in flexibility and delivery; and significantly better than Inventors in quality. With strong quality (4.80), delivery (4.55) and cost (4.50) capabilities, Leading Innovators appear to be capable of responding well to customer expectations with strong quality, quick and reliable delivery and efficient cost.

Regarding corporate performance, Leading Innovators have better innovative, production, market and financial performance levels. Their total sales are significantly highest as well (Table 5) and their growth in total sales is second best following Inventors.

4.3.3. Followers

Followers cluster is in fact the second most innovative cluster except their very low radical product innovations capability (1.71), for which it is nearly equal to the Laggers cluster. Clearly, Followers prefer to develop incremental product innovations (their higher score with 3.29) rather than radical ones (Table 3). They are also relatively strong at process and organizational innovations.

In operations priorities, where Leading Innovators dominate at each aspect, this cluster of firms slightly differentiated themselves in cost and quality rather than flexibility and delivery compared to the Inventors and Laggers clusters (Table 4). Followers have high quality and high cost efficiency capabilities (4.69 and 4.40, respectively), but their delivery level is lowest (4.29) among clusters. They give importance mainly to quality but care less for flexibility (3.61).

Followers have attained the second best level for financial performance and total sales behind Leading Innovators (Table 6). They have a strong market and production performance (3.90 and 3.85, respectively) and they significantly differ from the Laggers in innovative performance. Their growth rate in total sales is also acceptable with 22.4% annually.

4.3.4. Inventors

Inventors have only one very strong innovative capability; namely, radical products innovations (Table 3). Besides, they are also significantly better than Laggers in incremental products innovations. However, their process, marketing and organizational innovations levels are far lower than Leading Innovators and Followers. The difference between Followers and Inventors is that Inventors focus only on one aspect and thus outperform them in radical products; but Followers have more balanced innovative capabilities and they are better in process and organizational innovations.

Inventors are at the second place for delivery and flexibility and at the third place in cost and quality. They cannot significantly differentiate themselves in any operations priorities (Table 4). Considering the cluster means, it is noticed that quality is the most focused on priority among clusters. However, when excluding quality, Inventors give more importance to delivery/dependability rather than cost efficiency. This is similar for Leading Innovators as well, but Followers prefer cost efficiency more than delivery/dependability.

Regarding corporate performance, Inventors are just behind the Leading Innovators in innovative, market and production performance (Table 5). But more importantly, Inventors have highest annual growth rate in total sales (30.9%).

4.3.5. Laggers

Laggers are the least innovative cluster in our study. They have the lowest scores in all innovation types among the clusters (Table 3). It can be said that Laggers do not even appreciate innovative capabilities as a component of firm strategy do not rely primarily on innovations for competitive advantage.

Laggers are the weaker cluster regarding operations priorities (Table 4). This cluster does not have any operational advantage over any other cluster. They manage to compete with Followers and Leading Innovators only in delivery, where they have very similar scores.

Consequently, due to their relatively weak position in innovative capabilities and operations priorities, Laggers have the worst performance scores. They are the tailender in innovative, market, production, and financial performance and in growth rate for total sales, which is only 12.5% annually. Note that the mean growth rate of the remaining three clusters is 25.9%.

5. SUMMARY AND CONCLUSIONS

This paper examines the innovative capabilities of manufacturing firms in the Northern Marmara Region in Turkey and clusters them accordingly, drawing on a sample of 184 manufacturing firms. A questionnaire is designed and conducted and various multivariate statistical procedures are performed in order to extract the relationships between innovative capabilities and operations priorities and corporate performance. The findings substantiate that manufacturing firms can be clustered according to their innovative capabilities leading to a taxonomy and that innovation clusters adopt and develop different operations priorities and that they attain diverse financial performance levels. These imply that there are alternative ways to compete in the market even within the same industry. However, each alternative strategy provides diverse levels of benefits to the enterprises.

Innovation and operations literature affirm that operations priorities and innovations are the crucial components of corporate strategies and they are the primary causes behind different performance levels. Our results support that innovative clusters put significantly more emphasis on operations priorities and they have also higher corporate performance.

More precisely, one of our clusters, Laggers, does not rely on innovative capabilities and eventually, they have the lowest operations and performance results and in the other extreme, the most innovative cluster, Leading Innovators, exploits operations priorities to attain the best overall corporate performance.

An implication extracted by comparing Inventors and Followers is that each aspect of the innovative capability is important and offers some degree of competitive advantage. Inventors have only an inclination to develop radical product innovations and they are the leader of total sales growth rate. Followers do not prefer to develop radical products but give balanced importance to process, organizational and incremental product innovations. Accordingly, their total sales are higher than Inventors and they have more balanced operations and performance capabilities.

All those findings demonstrate the vital importance of innovative capabilities for manufacturing firms in terms of operations priorities and corporate performance, and demonstrate further that high performing firms compete effectively on multiple operations priorities simultaneously. Hence, firms must excel in multiple priorities and innovations in their market rather than concentrate on a single operations priority and innovation type. These findings strengthen the results of Ferdows and De Meyer (1990) and Roth and Miller (1992) suggesting that firms may be competent in multiple operations priorities.

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REFERENCES

Alpkan, L., Ceylan, A., Aytekin, M., (2003), "Performance Impacts of Operations Strategies: A Study on Turkish Manufacturing Firms", *International Journal of Agile Manufacturing*, 6, 2, 57-65.

Andrew, P.J., Sirkin, H.L., (2006), "Payback. Reaping the Rewards of Innovation", *Harvard Business School Press*, Boston, Massachusetts.

Antoncic, B., Hisrich R. D., (2001), "Entrepreneurship: Construct Refinement and Cross-Cultural Validation", *Journal of Business Venturing*, 16, 495–527.

Barringer, B. R., Bluedorn, A.C., (1999), “The Relationship Between Corporate Entrepreneurship and Strategic Management”, *Strategic Management Journal*, 20, 421-444.

Benson, P.G., Saraph, J.V., Schroeder, R.G., (1991), “The Effects of Organizational Context on Quality Management: An Empirical Investigation, *Management Science*, 37, 9, 1107-1124.

Boyer, K.K., Leong, G., Ward, P.T., Krajewski, L., (1997), “Unlocking the Potential of Advanced Manufacturing Technologies”, *Journal of Operations Management*, 15, 4, 331–347.

Boyer, K.K., Lewis, M.W., (2002), “Competitive Priorities: Investigating the Need for Trade-Offs in Operations Strategy”, *Production and Operations Management*, 11, 1, 9-20.

Carmines, E.G., Zeller, R.A., (1979), “Reliability and Validity Assessment, Quantitative Applications in the Social Sciences”, Thousand Oaks, CA, Sage Publications 17, 22-27.

Choi, T., Y., Eboch, K., (1998), “The TQM Paradox: Relations among TQM Practices, Plant Performance and Customer Satisfaction”, *Journal of Operation Management*, 17, 1, 59-75.

Corbett, L.M., Campbell-Hunt, C., (2002),”Grappling with a Gusher! Manufacturing’s Response to Business Success in Small and Medium Enterprises“, *Journal of Operations Management*, 20, 495–517.

Dess, G.G., Robinson, R.B., (1984), “Measuring Organizational Performance in the Absence of Objective Measures: The Case of the Privately-Held Firm and Conglomerate Business Unit”, *Strategic Management Journal,* 5, 3, 265-273.

Ferdows, K., De Meyer, A., (1990), “Lasting Improvements in Manufacturing Performance: In Search of a New Theory”, *Journal of Operations Management*, 9, 2, 168-184.

Fornell, C., Larker, D.F., (1981), "Evaluating Structural Equation Models with Unobservable Variables and Measurement Error," *Journal of Marketing Research*, 18 (February), 39-50.

Flynn, B.B., Sakakibara, S., Schroeder, R., Bates, K.A., Flynn, J.E., (1990), “Empirical Research Methods in Operations Management”, *Journal of Operations Management*, 9, 2, 250-284.

Gunday, G., Ulusoy, G., Kilic, K., Alpkan, L., (2008), “Modeling Innovation: Determinants of Innovativeness and the Impact of Innovation on Firm Performance”, *Proceedings of the 4th IEEE International Conference on Management of Innovation and Technology*, 776-771, Piscataway, New Jersey.

Hagedoorn, J., Cloodt, M., (2003), “Measuring Innovative Performance: Is There an Advantage in Using Multiple Indicators?”, *Research Policy*, 32, 1365–1379.

Hair, J.F., Anderson, R.E., Tatham, R.L., Black, W.C., (2006), Multivariate Data Analysis: With Readings, *Pearson Prentice Hall*, 6th edition.

Hayes, R.H., Wheelwright, S.C., Clark, K. (1988), “Dynamic Manufacturing”, Free Press, New York, NY.

Hornsby, J.S., Kuratko, D.F., Zahra, S.A., (2002), “Middle Managers’ Perception of the Internal Environment for Corporate Entrepreneurship: Assessing a Measurement Scale”, *Journal of Business Venturing*, 17, 253–273.

Kathuria, R., (2000), “Competitive Priorities and Managerial Performance: A Taxonomy of Small Manufacturers”, *Journal of Operations Management*, 18, 627-641.

Malhotra, M.K., Steele, D.C., Grover, V., (1994), “Important Strategic and Tactical Manufacturing Issues in the 1990s”, *Decision Sciences*, 25, 2, 189-214.

McAdam, R., KEOGH, K., (2004), “Transitioning Towards Creativity and Innovation Measurement in SMEs”, *Creativity and Innovation Management*, 13, 2, 126-141.

Narver, J.C., Slater S.F., (1990),”The Effect of a Market Orientation on Business Profitability”, *Journal of Marketing,* 54, 20-35.

Noble, M.A., (1997), “Manufacturing Competitive Priorities and Productivity: An Empirical Study”, *International Journal of Operations & Production Management,* 17, 1, 85-99.

Nunnally, J.C., (1978). “Psychometric Theory”, *McGraw-Hill*, New York, NY.

OECD, (2005), “Oslo Manual: Proposed Guidelines for Collecting and Interpreting Technological Innovation Data”, Third Edition, Paris.

Porter, M.E., (1979), “The Structure within Industries and Companies’ Performance”, *Review of Economics and Statistics*, 61, 214–227.

Roth, A., Miller, J.G., (1992), “Success Factors in Manufacturing”, *Business Horizons*, 35, 4, 73-81.

Saraph, J.V., Benson, P.G., Schroeder, R.G. (1989), “An Instrument for Measuring the Critical Factors of Quality Management, *Decision Sciences*, 20, 4, 810-829.

Sum, C., Kow, L.S., Chen, C., (2004), "A Taxonomy of Operations Strategies of High Performing Small and Medium Enterprises in Singapore", *International Journal of Operations & Production Management*, 24, 3, 321-345.

Vickery, S.K., Droge, C., Markland, R.E., (1993), "Production Competence and Business Strategy: Do They Affect Business Performance?", *Decision Sciences*, 24, 2, 435-455.

Voss C.A., (1995), "Alternative Paradigms for Manufacturing Strategy", *International Journal of Operations & Production Management*, 15, 4, 5-16.

Ward, P.T., Mccreery, J.K., Ritzman, L.P., Sharma, D., (1998), "Competitive Priorities in Operations Management", *Decision Sciences*, 29, 4, 1035-1046.

Ward, P., T., Duray, R., (2000), "Manufacturing Strategy in Context: Environment Competitive Strategy and Manufacturing Strategy", *Journal of Operations Management*, 18, 3, 123-138.

Yilmaz, C., Alpkan, L., Ergun, E., (2005), "Cultural Determinants of Customer- and Learning-Oriented Value Systems and Their Joint Effects on Firm Performance", *Journal of Business Research*, 58, 1340-1352.

Zahra, S.A., (1993), "Environment, Corporate Entrepreneurship and Financial Performance: A Taxonomic Approach, *Journal of Business Venturing*, 8, 4, 319-340.

Zahra, S.A., Sidhartha, R. D., (1993),"Innovation strategy and financial performance in manufacturing companies: An empirical analysis," *Production and Operations Management*, 2, 1, 15-37.