Innovation Determinants in Manufacturing Firms

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Abstract. In this paper the findings of an empirical study concerning the innovation determinants in manufacturing firms is presented. The empirical study covers 184 manufacturing firms located in the Northern Marmara region of Turkey. The types of innovation considered here are product, process, marketing and organizational innovations. An extensive literature survey on innovation determinants is provided. A model is proposed to explore the probable effects and the amount of contribution of the innovation determinants to firm's innovativeness level. Among all possible determinants considered, intellectual capital has the highest impact on innovativeness followed by organization culture.

Keywords: Innovativeness Model, Innovation, Innovation Determinants, Empirical Research, Manufacturing Industry.

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1. Introduction

Recently, firms and countries found themselves facing the challenge of global competition. The influence of this global competition in business environment forces the firms to alter their business strategies. New product development, increased capability in products and production strategies, opening up of new markets, and appraisal of their supply chain management are some of the alternative strategies commonly exploited in order to shape the competitive advantage that firms try to obtain. Innovativeness is increasing its significance among firms' strategies due to its evident contribution to the competitive advantage of firms and it becomes one of the fundamental instruments of firms' business strategies to enter new markets, to increase the existing market share and to create competitive advantage. Therefore, innovation management research has become very important globally in recent years (Hitt et al., 2001; Kuratko et al., 2005).

Nowadays, the objective of innovations is not only reducing the costs but also a wide spectrum of reasons such as improving product and service quality, designing better products, enduring the shortened product life cycle, responding to customer needs and thus developing new services and products, new organization models and new marketing techniques. In the literature, various researches conclude that the modern companies need to be innovative in order to compete better in their market (Evangelista et al., 1998).

We can describe innovation as a continuous change in business processes, services and products of the firm that is under the pressure of strong competition in order to gain competitive advantage and to upgrade the efficiency of work, especially in the highly

dynamic market conditions of today. Innovations can be considered as the successful development and application of *new knowledge*, with the purpose of launching newness into the economic area and transforming knowledge into *profit*. Schumpeter (1934) differentiated between five different types of innovation: new products, new methods of production, new sources of supply, the exploitation of new markets, and new ways to organize business. Drucker (1985) defined innovation as the process of equipping in new, improved capabilities or increased utility.

In this research, OECD Oslo Manual (2005), which is the primary international basis of guidelines for defining and assessing innovation activities as well as for compilation and use of related data, has been taken as the fundamental reference source to describe, identify and classify innovations at firm level. In the Oslo Manual, four different innovation types are introduced. These are *product, process*, *marketing* and *organizational* innovations.

In the Oslo Manual, product innovation is defined as the introduction of a good or service that is new or significantly improved regarding its characteristics or intended uses. Process innovation is defined as the implementation of a new or significantly improved production or delivery method. Note that the product innovation and the process innovation are closely related to the concept of technological developments and usually referred to as the *technological innovations* in the literature. A marketing innovation is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing. Finally, an organizational innovation is defined as the implementation of a new organizational method in the firm's business practices, workplace organization or external relations.

This paper focuses on detecting various innovation determinants in order to understand how innovations are produced at the firm level and revealing the main factors that create an innovative environment in the manufacturing firms. By discovering important innovation

determinants, we claim that the innovativeness capability of a firm can be estimated and policies to improve its innovativeness can be determined. Here, innovativeness is defined as a measure obtained by merging four innovation types performed, namely, product, process, marketing and organizational innovations.

The study of the innovation determinants was part of a research project conducted with the objective of proposing and verifying an integrated innovativeness model consisting of two sub-models: the drivers of innovativeness model and the performance model of innovation (**Figure 1**). To the best of our knowledge, so far, such a comprehensive model of innovativeness was hardly ever appraised and evaluated in the literature. The performance model of innovation aims to assess the impact of innovativeness on firm performance, which can be measured through certain performance indicators such as the production performance, marketing performance, innovation performance and financial performance. The proposed model argues that in-firm and out-firm innovation determinants settle the innovative capability at that firm, which ultimately influences and affects the above mentioned performances and hence the competitiveness of the firm in its market. The performance model is introduced here only briefly for the sake of completeness. The model and the results obtained are reported in detail elsewhere (Gunday et al., 2009a).

{PLEASE INSERT FIGURE 1 AROUND HERE}

In the next section, the research background and the proposed integrated innovativeness model will be presented. Section three will cover details about the data and the measurement of variables. Later, the analysis methodology and findings of the study will be provided in

section four. Finally, we will provide a discussion, concluding remarks and further research problems in the fifth section

2. Research Background

2.1. Innovation Determinants

Due to massive global competition, less innovative firms face decreasing market share. Thus, firms begin to operate their innovation strategies with the purpose of gaining competitive advantage (Drucker, 1985; Hult et al., 2003). In order to lead the competition race, firms try to differentiate themselves from their competitors in the market by implementing various strategies, such as positioning themselves as the most innovative, as the most cost efficient, as the most responsive to market changes, etc. The companies that try to position themselves as the most innovative one in the market, struggle to find out the customer needs that are not met yet and develop new products and services to satisfy these needs. Some companies turn out to be more successful than the others in achieving this objective due to various internal and external factors they possess. These factors that affect the innovativeness, i.e. the innovative capabilities of the companies are referred to as the *innovation determinants* in the literature.

Conjectural studies are the pioneers of the innovation literature which has grown and matured by the contribution of researchers, who tried to elucidate the innovation concepts by defining organizational policies, processes and characteristics whereby firms develop innovative and creative ideas regarding their products, processes, and markets (Stevenson, and Jarillo, 1990; Hitt et al., 2001).

Firms are the basic units where innovations occur. Innovations can be created in several ways in firms. Besides invention, adapting and imitating can also be very useful firm

strategies leading to innovations. A company can be innovative by taking an idea from other firms or sectors and adjusting it for its own purposes. To be capable of launching an innovation, a firm usually needs to merge a number of different types of skills, capabilities, knowledge and resources (Fagerberg et al., 2004)

{PLEASE INSERT TABLE 1 AROUND HERE}

A large number of studies in innovation literature have been carried out in order to determine which factors enhance innovative efforts of firms (Damanpour, 1991; Sundbo, 1999; Barringer and Bluedorn, 1999; Antoncic and Hisrich, 2001; Belderbos, 2001; Hornsby et al., 2002; Montalyo, 2004; Wan et al., 2005; Jaumotte and Pain, 2005; Subramaniam and Youndth, 2005; Vinding, 2006). **Table 1** summarizes the literature about the innovation determinants that constitute the theoretical background of our drivers of innovativeness model.

2.2. Drivers of Innovativeness Model

The innovation determinants that are considered in this paper can be grouped in two categories: indigenous and exogenous. The indigenous parameters include general firm characteristics (firm age, size, ownership status and foreign capital), firm structure (intellectual capital and organization culture), and firm strategies (such as collaborations, knowledge management, investments strategies and operations priorities). On the other hand, exogenous parameters are sector conditions (market structure, public regulations and incentives, and barriers to innovation).

Fagerberg et al. (2004) stressed the importance of organization culture in the innovation making process and claimed that it is necessary to prevent internal resistance in the organization in order to be able to create new practices and work processes. Actually,

innovation is the outcome of incessant struggle within the firm, which provides new solutions to particular problems. Hence, the organizational structure, the leadership style of entrepreneurs, the effect of ownership structure are some of the subjects that must be analyzed among the innovation determinants together with firm culture components such as reward system policies, managerial support of idea generation and project formulation, time availability, risk taking for innovativeness and work discretion.

Intellectual capital constitutes a valuable asset for firms in their innovation activities. Intellectual capital is discussed in the literature under three sub-headings (Edvinson, 1997). These sub-headings are human capital, social capital, and organizational capital. Human capital is related to talents, specializations, capability of developing new and creative ideas of individuals in an organization. Social capital consists of the relationships among the members of organizations, the sharing of ideas and information, ability to learn together or to teach to each other and the ability of finding, analyzing and solving common problems. Organizational capital is the sum of organization policies and practices documented in an explicit fashion in procedures, handbooks and databases; and finally the intangibles such as patents and licenses obtained or purchased by companies as a result of their past innovations. How much the intellectual property protection and the associated laws are encouraging firms to be more innovative is a critical question still open for further research.

Innovation activities in firms also depend on external sources and collaborative applications, which have a positive influence on the innovation process. The level of interaction with external sources and the dynamism of the innovative environment within the firm are closely related and interwoven. This approach enhances the innovative capabilities of both individual companies and their entire network.

Similarly, public incentives and other related governmental measures are crucial for the effectiveness of the innovation process. Among others, they provide funding and tax breaks

for R&D activities, favourable tax regulations as incentives for innovations, financial support during the marketing phase of the innovations, and laws and regulations for the protection of the intellectual property. On the other hand, market intensity and dynamism, customers' expectations, demands and suggestions, competition in the market, competitors' R&D and innovation policies, all have undeniable impacts on the policies companies adopt towards innovation.

Companies gain additional competitive advantage and market share in their target market according to the level of importance that they attach to manufacturing strategies prevailing in the market such as price, quality, flexibility, and on-time delivery. These are vital factors for companies to build a reputation in the market and therefore to increase their market share.

To sum up, innovativeness in a firm is a joint outcome, among others, of firm characteristics, firm structure, firm strategies and external conditions. These innovation determinants with all their sub-elements are presented in a model in **Figure 2** referred to here as the drivers of innovativeness model.

{PLEASE INSERT FIGURE 2 AROUND HERE}

3. Data and 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 general characteristics, business strategies, intellectual capital, innovativeness efforts, competitive priorities, market and technology strategies, in-firm environment, market conditions and corporate performance. That is to say, in order to collect the data that is

necessary to validate the proposed model. The initial survey draft was discussed with various firms' executives and it was pre-tested through 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 manufacturing sectors in the Northern Marmara region in 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 in the context of an emerging country.

A sample of 1,674 manufacturing firms was obtained by selecting randomly from the database of the Union of Chambers and Commodity Exchange (TOBB) and Istanbul, Kocaeli, Tekirdag Cerkezkoy and Sakarya Industry Chambers and member lists of various Industry Parks in Northern Marmara region within Turkey. When randomly drawing these firms from the larger sample, care was exercised to secure representative geographic and sector distributions of these firms within the larger sample. For each sector, number of firms in the sample turned out to be representative, since no significant difference ($p \leq 0.05$) has been detected between the population and sample percentages. Afterwards, the questionnaire was applied through a hybrid system of mail surveys and face-to-face interviews. Post analysis demonstrated that there were no major statistically significant differences among the answers to the questionnaires for the two modes of assessment. Out of the sample of 1672 firms, 184 complete responses were obtained resulting in 11% return rate.

Responding firms in our resulting sample are distributed among six main business sectors, namely automotive (20.1%), textile (19.6%), metal goods (19%), chemicals (17.9%), machinery (15.2%), and electrical home appliances (8.2%) industries. These industries were selected to represent the major manufacturing sectors in an emerging country such as Turkey.

All the respondents completing the questionnaire were from the top (52%) or middle management (48%).

Figure 3 depicts a profile of the resulting sample, illustrating its diversity in terms of annual sales volume, firm size (in terms of number of employees) and firm age. Firm size was determined by the number of full-time employees (up to 50: small; between 50 and 250: medium; 250 and above: large) and firm age is determined by the year production started (before 1975: old; between 1975 and 1992: moderate; 1992 and later: young). Annual sales volume was divided into 5 categories: less than 1M Euro; between 1M Euro and 5M Euro; between 5M Euro and 20M Euro; between 20M Euro and 50M Euro; and 50M Euro or more.

{PLEASE INSERT FIGURE 3 AROUND HERE}

After the data collection stage, multivariate statistical analyses via SPSS v17 and AMOS v16 software package were conducted in order to validate the research framework. Occasional missing data were randomly distributed (MAR) on items.

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 presented in **Table 1**.

Specifically, the questions about manufacturing strategies (operations priorities), organization culture, innovation barriers, intellectual capital, business strategies are enquired using a 5-point Likert scale and inquiring how important each item 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 empirical researches (Khazanchi et al., 2007).

The scales of the four different manufacturing strategies' 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). For business strategy items, we also benefited from Olson et al. (2005).

The scales of the three intellectual capital measures are constructed by inspiring from Subramaniam and Youndt (2005) with five, five, and four criteria, respectively. Similarly organizational culture measures are adapted from several criteria in OM literature based previous studies of Walker et al. (1987), Jaworski and Kohli (1993) and Menon et al. (1999).

The questions about innovative capabilities are enquired employing a 5-point Likert scale. The respondents are asked to indicate "to what extent are the related applications/practices implemented in your organization in the last three years" 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 regarding these capabilities is adapted mainly from Oslo Manual (2005). Each innovation construct is measured by its original measurement items, which are developed accordingly. Note that the innovation measures used in this research are partially new for the literature and required to be validated during the analysis.

4. Analysis and Findings

After the data collection phase various multivariate data analysis methods were performed. The multivariate data analysis, which was conducted in order to extract the underlying relationships between the innovation determinants and the innovativeness, was

performed in three stages. The first stage is the factor analysis stage where we established the constructs that were used during the second stage, namely, the structural equations modelling (SEM) analysis. Finally we conducted a Multiple Linear Regression (MLR) analysis in order to provide further support to the validity of the proposed framework and estimate its predictive capability.

4.1. Results for the Factor Analysis

The first stage is about extracting the factor structure of the research framework. We applied first-order principal component analyses (PCA) 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). Note that, the factor analysis is useful in order to observe the underlying patterns or relationships for a large number of variables and they determine whether the information can be condensed or summarized in a smaller set of factors or components. Hence, we employed factor analysis in order to explore how various items within each of the constructs (innovativeness and innovation determinants) interact with each other and to develop scales (by combining several closely correlated items) to be used in the following analysis on linkage (Kim and Arnold, 1996).

A PCA with varimax rotation is conducted in order to identify the underlying innovation determinants (firm manufacturing strategy, intellectual capital, organization culture, collaborations, and innovation barriers) and dimensions of innovations. Each factor is named appropriately so that the included variables are represented as closely as possible in order to avoid *naming fallacy*. After all of the basic constructs are obtained, for innovation determinants, we also conducted a second order PCA in order to reduce the obtained items to usable size and to achieve a more manageable set for subsequent SEM analysis. To sum up,

we obtained five innovation determinants constructs; namely, organization culture, innovation barriers, firm manufacturing strategy, intellectual capital and collaboration as well as the items that these constructs are materialized.

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) and unidimensionality tests. Cronbach α values ≥ 0.7 suggest a satisfactory level of construct reliability (Nunnally, 1978; Streiner, 2003). Moreover, convergent validity between the 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). Note that, a compelling demonstration of convergent validity would be an AVE score of 0.5 or above (Holmes-Smith, 2001; Fornell and Larker, 1981).

The second stage involves the analysis of the relationships between these factors using SEM approach. The findings and the results of SEM analysis will be presented next.

4.2. Results of the Structural Equations Modeling Analysis

Factors with eigenvalues (the amount of variance accounted for by a factor) larger than 1 were considered for further analysis as proposed in the literature (Kim and Mueller, 1978). Finally, the extracted factors are checked for normality, randomness and independency assumptions and thus data is validated for statistical tests. The scale value of each factor was determined by a simple average of the included items.

For the sake of space limitation, the details of the above discussed factor analysis are not included in this paper but each one of them was separately provided in Gunday et al. (2009b). Next, by using the constructs that are obtained after raw sample items (data) were factor analyzed. That is to say, we validated the integrated innovativeness model presented in **Figure 1** using SEM approach.

Note that, SEM procedure obtains weights, loadings and path estimates while performing an iterative scheme of multiple regressions until they converge to a solution. A single-step SEM analysis with the simultaneous estimation of both measurement and structural models is conducted by AMOS v16. The measurement model of SEM is based on the comparison of variance-covariance matrix obtained from the sample to the one obtained from the model (Bollen, 1989). The entire model is supported with the goodness-of-fit indices (**Table 2**).

{PLEASE INSERT TABLE 2 AROUND HERE}

These indices conform to the acceptable standards with the value of $\chi 2/df$ ratio of 1.717. This ratio shows the appropriateness of the model and should be within the range of 1-5, where lower values indicate a better fit (Wheaton et al., 1977). The goodness-of-fit indices exhibited in **Table 2** demonstrate an acceptable level of overall fit for the proposed model.

Figure 4 presents the results of the SEM analysis. Each arrow in the model is statistically significant ($p<0.05$). As a result, the proposed paths of relations matching innovation determinants to innovativeness are analyzed and validated regarding their significant path (regression) estimates.

According to the path estimates obtained by the SEM analysis, *intellectual capital* is observed to be the strongest driver of innovative capabilities. Among the factors under *intellectual capital*, *organizational capital* has the highest regression estimate. On the other hand, among the factors of *organization culture*, *management support* and *reward system* turns out to have the highest regression estimates.

Furthermore, it is found that innovation determinants, namely *intellectual capital, organization culture, firm manufacturing strategy and collaborations* have positive and

innovation barriers have negative impact on innovativeness. There is no controversy with this result and it was expected based on the existing literature.

Note that the second stage of the model, which is not included in this paper, demonstrates that the innovativeness capabilities of a firm enhance the corporate performance, which directly stimulates its financial performance (Gunday et al., 2009a). Therefore, based on these two results we can acknowledge the existence of a resulting innovativeness path starting from the proposed innovation determinants leading ultimately to a higher financial performance.

There are some differences between the hypothesized model in **Figure 2** and the model validated with the SEM analysis in **Figure 4**. These are partly due to the results of the factor analysis. For example in **Figure 2**, we hypothesized that *Intellectual Capital* and *Organization Culture* are subparts of another construct which was referred to as the *Firm Structure*. However the factor analysis results implicated that, the items that compose these constructs can't be grouped under a single construct and should be treated as two different constructs. Similarly, the *formalization* item was hypothesized to be part of the organization culture. However, the factor analysis misplaced formalization under the *intellectual capital* construct so we decided to eliminate it in the SEM analysis and include only to the MLR analysis.

On the other hand, some of the innovation determinants such as the *general firm characteristics* (i.e., *size, age, owner ship status and foreign capital*) and *innovation outlay* are in a different scale (the answer to these determinants have either nominal values or logical values such as yes or no). Same thing is true for the *marketing and technology strategies.* Therefore, it was not suitable to include them to the SEM analysis. The *firm characteristics* were treated as control variables and more appropriate statistical analysis (*correlation analysis, t-tests, ANOVA, etc.*) were conducted in order to assess their effect to the innovativeness at the firm level. The results of this further analysis will be presented later in

subsection 4.4. Finally, some of the constructs such as the *public incentives, market dynamism & intensity* and *monitoring strategies* were excluded from the SEM analysis since they were deteriorating the underlying factor structure. Therefore, we decided to include these determinants only in the MLR analysis that was conducted in the third stage of the analysis. Next, we will present the results of the MLR Analysis.

{PLEASE INSERT FIGURE 4 AROUND HERE}

4.3. Results of the Multiple Linear Regression Analysis

In order to assess the predictive performance of the proposed model in **Figure 2**, we also conducted an MLR analysis. In terms of model validation SEM analysis is more powerful than other techniques such as MLR due to the fact that it allows a multilayer structure (*e.g.*, it allows inclusion of latent variables) and determines the path (regression) estimates simultaneously for the underlying multilayer model. On the other hand, MLR assumes a two layered structure where the dependent variable regresses on the independent variables. However, MLR is still a more common tool among the researchers due to its simplicity, particularly while assessing the predictive performance of a hypothesized model. Furthermore, the two layered structure provides the opportunity to analyze the effect of each variable individually, rather than as part of a hypothesized higher layer construct and such analysis which might yield invaluable insights of the model. Therefore, we decided to include our MLR analysis in this paper.

The relationship between the innovation determinants and the innovativeness is highly nonlinear and requires the implementation of techniques other than MLR analysis. Further nonlinear analysis of the data is beyond the scope of this research and left as a future research topic. However, as the results indicate, even a simple MLR analysis demonstrates a promising predictive capability of the proposed model. The resulting MLR model and the standardized beta coefficients are tabulated in **Table 3**.

{PLEASE INSERT TABLE 3 AROUND HERE}

Note that the *organizational culture*, which is a factor of the intellectual capital, seems to have the greatest relative effect on the firm level innovativeness based on the MLR analysis. This finding supports the result of the SEM analysis. We also depicted the actual innovativeness versus the predicted innovativeness graph for the resulting MLR model in **Figure 5**. The graph demonstrates that the predictive performance of the model is encouraging.

{PLEASE INSERT FIGURE 5 AROUND HERE}

4.4. Further Statistical Analysis

Recall that, general firm characteristic variables which were included in the hypothesized model were excluded from the SEM analysis due to the scales of their measures and rather treated as control variables. Further statistical analyses such as *correlation analysis*, *t-tests* and *one-way ANOVA* were conducted for the general firm characteristics variables. Based on this analysis, among the firm characteristics only *firm size* was determined to be

significantly correlated with innovativeness. The determined relationship between the firm size and innovativeness was almost linear rather than U-shaped as would be expected (Bound et al., 1984). One-way ANOVA analysis for the innovativeness level of small, medium and large firms was conducted. As previously stated, employee numbers were used as a measure of the firm size. Findings report that innovativeness level of these three groups significantly differ ($p<0.05$) and large- and medium-size companies are performing better than the small-size companies in implementing innovations (**Table 4**).

{PLEASE INSERT TABLE 4 AROUND HERE}

Large-sized companies outperform the others in terms of innovativeness. On the other hand, firm characteristics such as firm age, firm ownership status, and existence of foreign capital in a firm did not yield significant effects on innovativeness based on the one way ANOVA analysis.

Note that, in our sample, large firms are more likely to be involved in collaborations, more likely to invest more on R&D and more likely to be more competent in intellectual property management. Contrary, small and medium size firms demonstrate weak results for patent applications, collaborations, use of public incentives and R&D investments.

5. Discussion and Conclusion

5.1. Discussion

The SEM results visibly stress that *intellectual capital* is the most important innovation determinant with standardized path estimate of 0.74. Along with the organization capital, social and human capital, which covers the skills, creativity and experience of individuals, are

determined to be the most valuable resources for innovation. Therefore we can safely propose that the firms should invest in human capital by improving education, training and learning opportunities and also they should develop innovation skills of their staff in order to improve their innovativeness. Note that, such a high quality human capital will result in higher social capital and consequently organizational capital of the firm will increase.

In terms of organizational culture, high correlation of management support and reward system (whose path estimates are 0.87 and 0.77 respectively) to innovativeness emphasizes the importance of managerial encouragement to idea generation and their support to new projects for innovative capabilities. Corporate world can easily turn into a barren environment where everybody pursue their daily tasks and can't find the quality time to conceive further innovations. Furthermore, usually the process of innovation also requires some time commitment and such dedication not results always with success. Management should support the employees and bear possible failures to some extent. They should make this policy public and motivate their employees to spare time for innovations by setting awards for successful innovations. Such awards might be of monetary type such as salary increase, extra payments or valuable goods, or might just be a simple recognition letter, which has a sentimental value.

Generally speaking, when the firm managers are faced with questions regarding to the barriers to the innovations, they mostly prefer to complain from the external factors (*exogenous*) rather than the internal factors (*indigenous*) as the source of barriers to innovation. They usually consider (or behave as such) that particularly the external limitations (such as limited funding, lack of motivating governmental regulations, etc.) and to a lesser degree external difficulties (such as difficulties of finding necessary components, materials, technological services, difficulty of adopting new products by customers, etc.) constitute the major barriers to innovation. They do affirm that the internal limitations (such as time and

financial limitations, higher risk and cost of innovation) and internal deficiency (lack of technical information and experience, lack of qualified employee and lack of qualified R&D manager, etc.) are also important barriers to innovations but claim that their effects are minor with respect to exogenous barriers. Furthermore, internal resistance is usually considered as the least significant barriers to innovations by the managers. However, the SEM analysis demonstrates that *indigenous* factors such as internal deficiency and internal limitations have the most significant regression values among the factors that constitute the barriers to innovation. Moreover, the internal resistance is revealed to be a factor that is as important as the *exogenous* factors. Therefore, in order to become more innovative, firms should look inside and solve their internal problems. They should also consider the possibility that internal resistance to change might in fact be an important reason of being less innovative. It comes usually easy to point the finger to the others particularly when you are responsible from the current state of the internal environment. However, in reality the managers should find the ways to overcome the internal barriers in the first place.

Among various forms of collaborations vertical collaboration has the highest and operational collaboration has the second highest regression value. Note that, generally speaking, the collected data suggests that the firms do not widely prefer to collaborate. Vertical collaborations (with customers and suppliers) and operational collaborations are relatively common but particularly R&D collaboration is a concept that firms mostly fail to realize (such as pre-competitive R&D). In our sample, large firms involve in collaborations more likely than the smaller ones. Moreover, they also invest more on R&D and finally they are more likely to be more competent in intellectual property management. Contrary, small and medium sized firms have weak results for patent applications, collaborations, use of public incentives and R&D investments. The SEM results suggest that collaboration has significant effect on innovativeness hence it is a factor that upper management should not turn

a blind eye. In that sense, the collaborations, particularly the R&D collaborations which are utilized least by the companies, are open for significant improvements in a company and such a policy leads to a more innovative environment.

Among the innovation determinants, firm strategies constitute important business philosophy since internal/external growth and manufacturing strategies have major roles for their innovative performance. Furthermore, increased productivity is clearly a very important driver of business success. Based on the SEM analysis, we can confidently state that our data supports that the manufacturing strategy is in fact positively linked with innovativeness. As path estimates on **Figure 4** demonstrates, although production quality is still the top priorities for manufacturing firms, cost efficiency and on-time delivery/reliability are also among the crucial factors. Among the latter two, production cost efficiency seems the leading determinant for firms to be more innovative.

5.2. Conclusion and Further Research Directions

This paper reports on an innovativeness study in the Turkish manufacturing industry, drawing on a sample of 184 manufacturing firms. It has empirically tested a framework identifying the relationships among innovativeness and innovation determinants.

The results of various statistical analyses demonstrate that innovation determinants such as firm culture, intellectual capital, market focus as well as technology development and manufacturing strategies, collaborations, monitoring for innovations outside the firm, innovation outlay, market dynamism, public incentives, and firm size all have significant positive effects on the innovative capability of a firm. Indigenous barriers on innovation and centralization of decision making, on the other hand, have significant negative effects on innovative capability of a firm. Firm characteristics such as firm age, firm ownership status, and the existence of foreign capital have separately analyzed as control variables and it is

found that in a firm they do not reveal any significant effects on innovativeness. Similarly, the relationship between exogenous barriers on innovation was not significant either.

One of the significant contributions of this research is the proposed framework which can be utilized to develop a rule engine for a decision support system that might assist upper management while developing innovation policies. Particularly the results of the MLR analysis encourage further research, which can utilize nonlinear approximation techniques that can analyze the data and establish the highly complex relationship between the determinants of the innovations and the innovativeness better. As previously mentioned this is beyond the scope of this paper and left as a further research problem.

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Table 1: Literature of Innovation Determinants

Category	Variables	Citations
Firm Characteristics	Firm Age	Koberg et al. (1996); Avermaete et al. (2003); Jung et al. (2003); Sørensen and Stuart (2000); Bertschek and Entorf (1996); Greve (2003)
	Firm Size	George et al. (2005); Peters and Van Pottelsberghe (2003); Evangelista et al. (1998); Benavente (2006); Lööf and Hesmati (2002); Crépon et al. (1998); Zahra et al. (2000); Camison-Zornoza et al. (2004)
	Ownership Status	Bishop and Wiseman (1999); Love et al. (1996)
	Foreign Capital	Bishop and Wiseman (1999); Love and Ashcroft (1999)
Firm Structure	Intellectual Capital	Dakhli and De Clercq (2004); Petty and Gutherie (2000); Shrader and Siegel (2007); Hitt et al. (2001); Bantel and Jackson (1989); Anker (2006); Wu et al. (2007); Marvel and Lumpkin (2007); Hayton and Zahra (2005); Subramaniam and Youndt (2005); Guangzhou Hu (2003); Romijn and Albaladejo (2002); Walker et al. (1987)
	Management support	Pinchot (1985); Damanpour (1991); Stevenson and Jarillo (1990); Hornsby et al. (1993); Kanter (1996); Sundbo (1999)
	Time availability	Burgelman (1984); Kanter (1985); Sathe (1985); Fry (1987); Damanpour (1991); Slevin and Covin (1997); Bamber et al. (2002)
	Work discretion	Sathe (1985); Quinn (1985); Antoncic and Hisrich (2001); Drucker (1985); Burgelman (1983); Zahra (1991)
	Reward system	Souder (1981); Fry (1987); Cissell (1987); Sykes and Block (1989); Kuratko et al. (2005); Eisenberger and Armeli (1997); Lawler and Porter (1967)
	Tolerance for risk taking	Antoncic and Hisrich, (2001); Lawler and Porter (1967); Souder (1981); Kanter (1985); Fry (1987); Hornsby et al. (2002)
	Formalization	Moenaert et al. (1994); Koberg et al. (1996); Darroch and McNaughton (2002); Wu et al. (2002)
	Centralization	François et al. (2002); Koberg et al. (1996); Gudmundson et al. (2003); Wu et al. (2002)
	Communication	Lukas and Ferrell (2000); Parthasarthy and Hammond (2002)
Firm Strategies	Collaborations	Sáez et al. (2002); Tether (2002); Koberg et al. (1996); Avermaete et al. (2003); Jung et al. (2003); Sørensen and Stuart (2000); Bertschek and Entorf (1996); Greve (2003); Fritsch and Meschede (2001); Keizer et al. (2002); Koschatzky et al. (2001), Landry et al. (2002); Mansfield (1998); Mansfield and Lee (1996); Romijn and Albaladejo (2002); Love et al. (1996)
	Innovation Outlay	Hall and Bagchi-Sen (2002); Parthasarthy and Hammond (2002); Lööf and Hesmati (2002); Crépon et al. (1998); Zahra et al. (2000); Camison-Zornoza et al. (2004)
	Monitoring Strategies	François et al. (2002); Lukas and Ferrell (2000)
	Market and Techonology Strategies	Koschatzky et al. (2001); Souitaris (2001); Beneito (2003); Galende and De la Fuente (2003); Belderbos (2001); Hitt et al. (1996, 1997); Landry et al. (2002); Romijn and Albaladejo (2002); Ahuja (2000); Ahuja and Katila (2001), Roper and Love (2002); Darroch and Mcnaughton (2002)
	Manufacturing Strategies	Motwani et al. (1999); Zahra (1993); Hayes and Schmenner (1978); Buffa (1984); Hayes and Wheelwright (1988); Wheelwright (1984); Hörte et al. (1987); Anderson et al. (1989), Leong et al. (1990)
Market Conditions and Relations	Market Dynamism and Intensity	Barringer and Bluedorn (1999); Miller and Friesen (1982); Covin and Slevin (1989); Pelham (1999); Terwiesch et al. (1996); Geroski (1995)
	Public Intensives	Beugelsdijk and Cornet (2002); Keizer et al. (2002); Jaumotte and Pain (2005)
	Barriers to Innovations	Coombs and Tomlinson (1998); Lanjouw and Mody (1996); Veugelers and Cassiman (1999)

Table 2: SEM Goodness of fit indices

Goodness of fit indices	Construct Performance	Reference value
χ^2 / degree of freedom	1.717	$1< \chi^2 / df <5$
CFI (Comparative Fit Index)	0.987	0.95<CFI<1
NFI (Normed Fit Index)	0.975	0.95<NFI<1
RFI (Relative Fit Index)	0.968	0.95<RFI<1
IFI (Incremental Fit Index)	0.989	0.95<IFI<1
TLI (Tucker-Lewis Fit Index)	0.982	0.95<TLI<1
RMSEA (Root Mean Square	0.063	RMSEA<0.08

Table 3: The MLR Model

Independent Variables	Beta	Standardized Beta
Human Capital	0.029	0.024
Social Capital	-0.010	-0.008
Organizational Capital (*)	0.462	0.527
Communication	-0.036	-0.029
Formalization	-0.056	-0.042
Centralization	-0.108	-0.108
Management Support	-0.058	-0.047
Work Discretion	0.230	0.199
Time Availability	0.005	0.006
Reward System	0.107	0.133
Internal Resistance	0.008	0.009
Internal Deficiency	0.041	0.053
Internal Limits	0.016	0.018
External Difficulties	-0.045	-0.043
External Limits	0.011	0.012
Monitoring Outer Milieu	0.100	0.120
Monitoring Inner Milieu	0.006	0.006
Monitoring Technical Sources (*)	-0.191	-0.225
Production Cost (*)	0.334	0.220
Production Flexibility	-0.094	-0.087
Production Quality	-0.063	-0.037
Market Dynamism (*)	0.238	0.222
Market Intensity	-0.128	-0.104
R&D Collaboration	0.275	0.090
Operational Collaboration	-0.028	-0.010
Vertical Collaboration	0.318	0.169
Technology Strategy	-0.037	-0.035
Production On-Time Delivery	0.015	0.012
Market Strategy (*)	0.337	0.312
Innovation Spending (M€)	0.026	0.107
Innovation Spending Increase (%)	0.149	0.137
Public Incentives	-0.073	-0.047
Innovation Spending Over Revenue (*)	-0.584	-0.174
Constant	-1.623	
R^2=0.744		Adjusted R^2= 0,590

(*) indicates that the result is significant with $p \leq 0.05$

Table 4 – Effects of firm size on innovativeness level

Firm Size	*%*	*Mean of Innovativeness Level* Subset for α=0.05		*p value*
Small	25	2.510		
Medium	49		2.914	**0.040**
Large	26		3.031	
Total	*100*	*2.843*		

Figure 1: Integrated Innovativeness Model

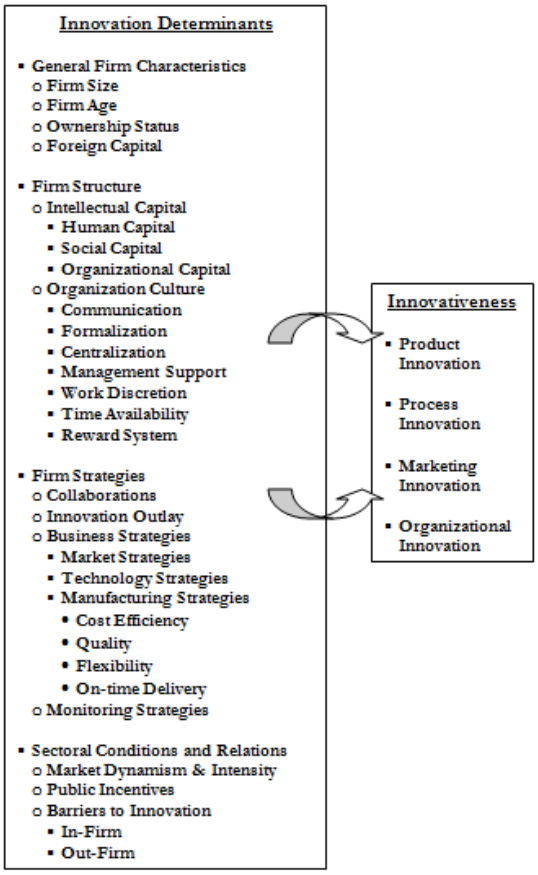

Figure 2: Drivers of Innovativeness Model

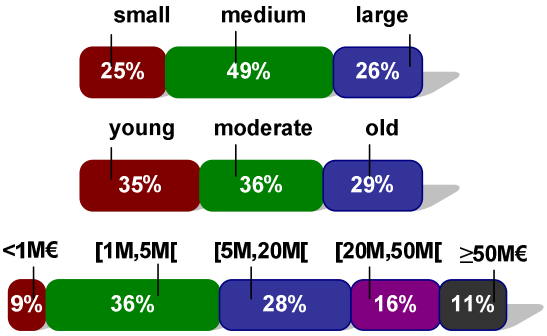

Figure 3: Sample Profile

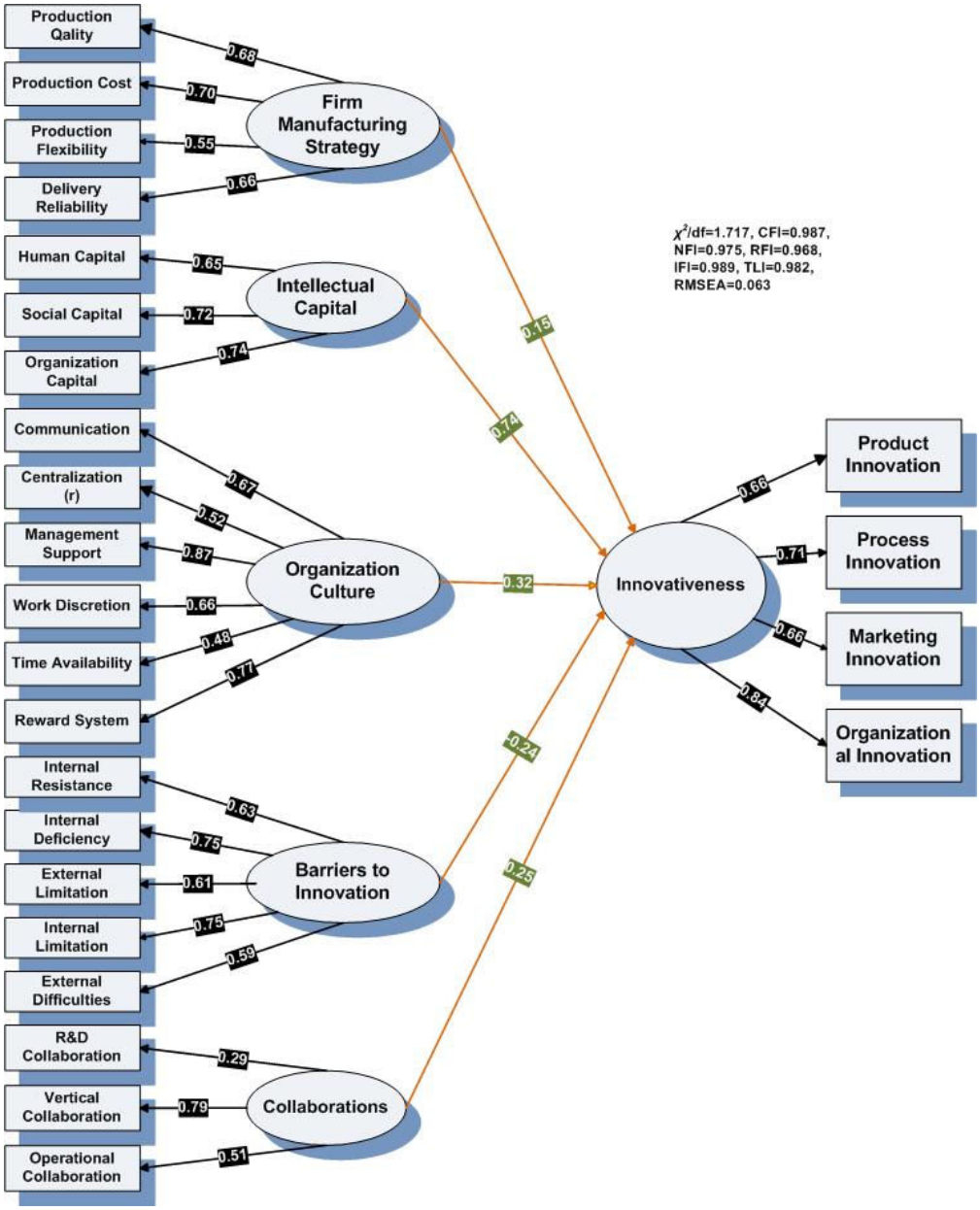

Figure 4: SEM of Drivers of Innovativeness Model

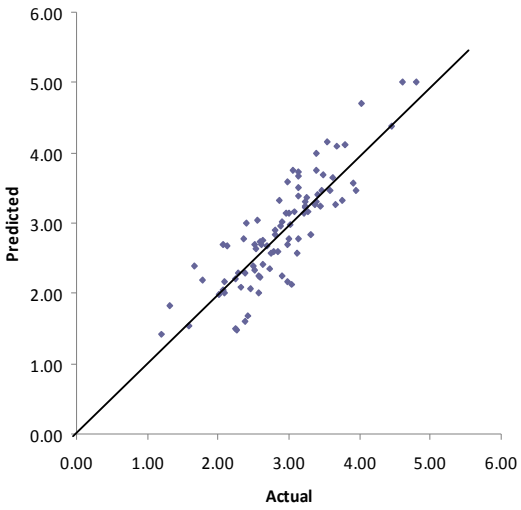

Figure 5: Actual innovativeness vs. the predicted innovativeness based on the MLR model