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. In the paper 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. Despite there is abundant research that analyzes the effects of various innovation determinants, this paper provides a comprehensive model and tests its validity. It is also unique in the sense that the significance of the innovation determinants is studied based on the empirical survey data. Such knowledge is invaluable for the decision makers in order to manage their innovation strategies and provides a guideline for effective allocation of their limited resources to be more innovative. The analysis reveals that 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

Effective management of innovative organizational climate and capabilities has been generally accepted to help firms achieve higher customer value leading to sustainable competitive advantage in the innovation management literature since many decades. Thereby, a long list of organizational drivers of innovativeness, i.e., organizational culture, human capital, organizational structure, leadership style, management support mechanisms, etc., came out. However, all the findings are not parallel to each other, i.e., a driver found effective in one study proved to be ineffective in another. Moreover, almost all of the empirical studies concentrated on only some specific parts or aspects of this list without controlling the other drivers.

In this study, therefore, instead of trying to add some new drivers conceptually and test their effects empirically, we try to adopt most of the already confirmed drivers and test their individual effects together -not separately, as opposed to the past literature. In other words, we try to see the big picture as much as possible. Doing this, we hope to measure and compare the individual effect sizes of different antecedents of innovativeness simultaneously. Thus, this paper focuses on developing and evaluating a comprehensive model of innovation determinants. This model will be used to select the most important factors that create an innovative environment in manufacturing firms and thereby suggest policies to improve innovativeness at the firm level.

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

During the last decades, 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 globally very important.

Firms are the basic units where innovations occur. We can describe innovation as a 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.

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.

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; Drucker, 1985; Hult et al., 2003). 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.

2.1. Innovation Determinants

In recent years, the subject of innovation determinants at firm level has been frequently discussed and it has become one of the important research areas in the innovation literature. Results of the empirical studies conducted mostly in developed nations showed that the effects of proposed innovation determinants were not confirmed in all of the studies.

Moreover, some authors also pointed out that more empirical studies should be conducted in diverse cultures and industries to facilitate the understanding of innovation making process with all its dimensions (e.g. Hornsby et al., 2002; Kemelgor, 2002). Thereby, there is a strong need to re-test the proposed but not totally confirmed effects of the long list of innovation determinants derived from the innovation management literature by developing a comprehensive hypothetical model.

The long-term success of a firm is only possible with concordance to its surroundings and with the integration of its interior dynamics to its environment (Yılmaz et al., 2005). Actually, a review of the relevant literature, demonstrates that the innovation determinants can be classified in two subgroups: in-firm (indigenous) parameters and out-firm (exogenous) parameters. The indigenous parameters include general firm characteristics (such as firm's age, size, ownership status etc.), intellectual capital (human capital, social capital, organizational capital), firm structure (formalization, centralization, communication), firm culture (firm decision making process and openness of in-firm communication channels, delegation of works, managerial support, reward system, etc.), and firm strategies (such as collaborations, knowledge management, investments strategies and cost strategies, pressure of competition elements, etc.). On the other hand, exogenous parameters are industrial conditions and relations (such as business sector and market structure, public regulations and incentives, external financial funds acquisition, and out-firm barriers to innovation). Next, these factors and their relevance to innovativeness will be discussed in detail.

2.1.1. General Firm Characteristics

The general firm characteristics that are relevant in terms of the innovativeness in firm level can be listed as the existence of the foreign capital, ownership structure, the size of the firm and the age of the firm.

Empirical studies find out that the foreign affiliations have uncertain effects for innovativeness. For instance, Bishop and Wiseman (1999) declared that foreign capital negatively influenced firms' innovative capabilities and R&D functions. Peters and Van Pottelsberghe (2003) examined the innovation competencies and performance of Belgian manufacturing firms. They indicated that foreign firms invested significantly less in R&D than local firms. But, Love and Ashcroft (1999) claimed that foreign ownership is positively correlated with innovations. Consequently, despite many studies in the literature that observed the companies with foreign origin are more innovative, findings regarding the direction and intensity of the relation between the foreign capital and innovation are indefinite.

Similar to the existence of foreign ownership, firm size also has some ambiguous affects for firm innovativeness abilities. Peters and Van Pottelsberghe (2003) found that large firms were better in terms of innovation competencies. However, according to their study, both large and small firms have more patents applications and R&D investments than medium sized firms. The authors also stressed that the share of turnover because of incremental innovation is higher within small firms, but technological breakthroughs are more vital within large firms. Evangelista et al. (1998) studied the innovative firms in different manufacturing sectors in Europe and investigated the effect of their firm size. They found that the percentage of innovativeness was higher for large firms than for smaller ones. They also expressed that innovation inputs like R&D investments were strongly correlated to firm size, and differed seriously across industries with little change across countries. Love and Ashcroft (1999) also claimed that the plant size was positively correlated with innovations. Camison-Zornoza et al. (2004) verified the existence of a significant and positive correlation between size and innovativeness. On the other hand, Lööf and Hesmati (2002) investigated the effect of firm size to R&D expenditure by using an econometric model. The authors found that if industry is controlled, innovation intensity was not constant but fell significantly with size. Similarly,

Bound et al. (1984), based on the analysis of a large panel data of 2600 US manufacturing companies, state that the small firms have much larger output of patents per R&D dollar spent, with a decreasing inclination to patent with size of R&D programs,

In the literature there are three schools of thought regarding to the influence of firm's age and the level of innovativeness. One school claims that the older firms have the experience to make innovations (e.g., Sørensen and Stuart, 2000), whereas the others claim that the so called experience acts as a barrier to introduce new ideas hence inversely proportional with innovativeness (Hansen, 1992), yet there exists those which states that firm age has no impact on innovativeness (Freel, 2003). There are also some researchers that claim that firm age has different impact on different types of innovations. Avermaete et al. (2003) claims that the impact of the firm age indeed is somewhat ambiguous. As a result of their analysis, they conclude that the older firms are more likely to introduce products that are also new to the market segment in which they compete, young firms tend to introduce innovations that have a larger impact on the firm's turnover.

George et al. (2005) examined that the ownership structures of small and medium sized firms influence their tendency to take risks and swell the scope and scale of innovativeness efforts. The results of their analysis based on 889 Swedish small and medium sized firms reveals that the companies that are owned internally (by the CEO and other senior managers, etc.) tend to be more risk adverse than those that are externally owned (venture capitalists, institutional investors, etc.). Tribo et al. (2007) used data from 3638 Spanish firms and analyzed the relationship between the type and number of shareholders and the R&D activities. Their result shows that the impact of large share holders to R&D investment is negative if the large shareholder is a bank, positive if it is a nonfinancial corporation and neutral if an individual.

2.1.2. Firm Climate and Structure

Individual efforts of employees for innovativeness are maintained by the impact of firm climate, structure and human capital on corporate ambience, which appears on firms' business applications and strategies, managerial tools and internal communication practices (Fry, 1987). Competitive reflection of firm climate and its innovative orientation depend on the success of conversion of the challenging new ideas of employees to corporate practices and investments (Pinchot, 1985; Kuratko et al., 1990; Hornsby et al., 2002). Innovative capability of a firm thrives when this conversion process is instilled in firms' business methods, practices, strategies and efforts (Sathe, 1988; Kanter, 1996). Numerous researchers investigated firm climate and structure and tried to find out appropriate internal factors for innovativeness. These factors can be combined into some related categories, namely intellectual capital, firm structure, and supportive mechanisms for the creation of an innovative climate.

A suitable climate for innovativeness which is especially related to intrapreneurship, i.e., entrepreneurship and innovativeness at the individual employee level, can be shaped by some managerial arrangements, such as management support for generation new ideas, allocation of time availability, work discretion, appropriate use of incentives and rewards, and tolerance for failures in creative undertakings and risky innovation projects (Kuratko et al., 1990; Damanpour, 1991; Hornsby et al., 1993; Kanter, 1996; Sundbo, 1999; Hornsby et al., 2002; Alpkan et al., 2010). In this respect, encouragement of new idea generation and development is excepted to positively influence a firms' entrepreneurial behaviour and enhance potential intrapreneurs' perceived trustworthiness to their organizations in terms of detecting opportunities and willingness to develop novel or useful ideas and/or projects and to take risks to actualize them (Stevenson and Jarillo, 1990). Availability of free time for employees is another critical factor for their both daily routines and intrapreneurial ideas and activities, i.e. time to imagine, observe, experiment and develop (e.g., Pinchot, 1985; Fry, 1987) since most

of the enthusiastic intrapreneurs make their pioneering steps to actualize their idealized projects in their spare times (Ende et al., 2003).

Moreover, autonomous work arrangements such as work discretion i.e. ability to take initiative in decision making, and planning flexibility, i.e., ability to revise plans to cope with rapid environmental changes leading to a higher degree of organizational adaptability are assumed to increase the speed and effectiveness of the innovative processes and then the organizational performance in general (e.g. Alpkan et al., 2007; Gurkov, 2009). Besides, if the employees have a high level of trust in the reward system of their organization, and also if they feel free from any punishment, adverse criticism, or loss of support in case of failure of their projects or ideas, then their commitment to innovative attempts will be increased (e.g., Morrison/Robinson, 1997; Chandler et al., 2000**).**

Beyond the encouragement of innovativeness at the employee level, a more comprehensive inner factor is the general structure of the organization. The structural characteristics which are mostly addressed in the literature are formalization, i.e., the extent to which work roles are structured and the activities of the employees are governed by rules and procedures, centralization, i.e., concentration of the decision making power at the top of an organizational hierarchy, and communication, i.e., exchange of information, mutual understanding and shared meaning among members of the organization. Donaldson (2001) argue that innovation requires low formalization and centralization, but higher levels of internal communication. Accordingly an organic structure that enables a participatory inner environment where market and technical information and decision making authority are distributed to lower levels and where strict rules do not govern experimentation and trial efforts fosters innovation (Burns and Stalker, 1969; Koberg et al., 1996).

2.1.3. Intellectual Capital

Intellectual capital, i.e., total stocks of all kinds of intangible assets, knowledge, capabilities, and relationships, etc, at employee level and organization level within a company has attracted much attention in the innovation literature (Zerenler et al., 2008). It is examined under three subgroups; namely, human, social and organizational capital. The human capital is the sum of knowledge and skills that can be improved especially by education and work experience of the employees of an organization (Joia, 2000; Dakhli and De Clercq, 2004). The social capital is the knowledge embedded within, available through and utilized by interactions among individuals and their networks of interrelationships (Nahapiet and Ghoshal, 1998). The organizational capital is the institutionalized knowledge and codified experience residing within and utilized through databases, patents, manuals, structures, systems, and processes (Youndt et al., 2004).

Within all of the dimensions of the intellectual capital, a knowledge-intensive organizational resource is embedded which stimulates innovation. All of the three dimensions are found to be associated with innovative performance in various studies. Subramaniam and Youndt (2005) examined the importance of intellectual capital of a company in term of its effect on innovative capabilities. The authors found that intellectual capital selectively influenced incremental and radical innovative capabilities. They stated that organizational capital positively affects incremental innovative capability, whereas human capital interrelated with social capital positively affects radical innovative capability. Human capital is negatively associated with radical innovative capability. Intriguingly, social capital played a noteworthy role in both types of innovation, as it positively affects both incremental and radical innovations.

Cohen and Levinthal (1989) stressed that human capital of a firm has a vital role for innovativeness, as it provides the ability to obtain and make use of the outcomes of other

firms' R&D activities. Also, Hall and Mairesse (2006) indicated that a great deal of the knowledge created by firm activities is embedded in the human capital to some extent. Vinding (2006) announced that firms that greatly have educated their employees are more probable to launch radical innovative products or processes (radical means new to the world).

Landry et al. (2002) examined the role of social capital on innovation decisions. Based on data collected from 440 manufacturing firms in Quebec, they concluded that diverse forms of social capital influenced the innovation decisions and increase in social capital increased the likeliness of innovation. Ruuskanen (2004) analyzes the data collected from Finnish SME's and demonstrates that social capital correlate statistically significantly with the overall innovation activities of the firms. They state that it enhances innovations through knowledge spillovers.

2.1.4. Firm Strategies

The innovative capability of a company depends on many factors including understanding of the customers' needs, attention to the market, efficient development of production technologies, and senior leadership. Understanding the market is an important business practice since the acquisition of marketing information is highly correlated to innovation success. Besides, Loch et al. (1996) expressed that internal and external growth strategies of firms play major roles in their innovative performance. Furthermore, increased productivity is clearly a very important driver of business success.

Belderbos (2001) investigated the statistical effects of business strategies in term of innovative performance. The research have indicated that the number of innovations of a company is positively and significantly correlated to R&D intensity, export intensity, manufacturing intensity and operating experience in manufacturing. The results have supported technology exploitation and sourcing motive for R&D investments. François et al.

(2002) showed that firms' financial and control strategies are also critical business practices that must be administered carefully for market success and innovative performance.

Roper and Love (2002) analyzed the relation between innovativeness and the export performance at firm level. They found that innovative firms are exporting more and the product innovation has a strong effect on the probability and propensity to export. Similarly, Geroski (1995) expressed that export oriented firms are more innovative than their more domestically oriented competitors, but this do not appear to cause a noticeable performance gap neither in terms of profitability, nor growth. In addition to significant differences identified between innovative and non-innovative plants, there are also differences in absorption of spillover effects. Roper and Love (2002) explored that innovative plants are more effective in their ability to exploit spillovers from the innovation activities of companies in the same sector. The returns of innovation in terms of increased ability to enter export markets and increase export sales is obvious. Thus, the authors stressed that innovativeness and success in product innovation both have positive effects on exports.

Darroch and Mcnaughton (2002) showed that incremental and radical innovations do not generally take place in firms which respond to market knowledge or have an effective marketing function but in firms which are sensitive to information about changes in the marketplace and respond to technology knowledge. Moreover, radical innovations are expected to come from firms with a technological orientation. The authors added that technological orientation provides firms to develop innovations that change consumers' behaviour without destroying their business competencies.

Diversification, differentiation and cost reduction strategies are also relevant innovation determinants discussed in the literature. (Montwani et al., 1999; Ahuja and Katila, 2001). Galende and De la Fuente (2003) observed the differentiation technique has definitely a positive impact upon the innovative capability of a company. Hitt et al. (1997) showed that

internationalization is also a useful business strategy for better performance; but this strategy provides competitive advantage only if the firm applies differentiation strategies in the market as well. At this point, internationalization implies considering global markets as primary target and selecting the employees from diverse countries.

Although there is a general consensus on the statement that competitive advantage and market share are slightly lost for just a limited time after radical innovations appear in the market. Top managers and employees of the companies should resist this fact while developing new skills and putting aside their older knowledge and methods in order to keep up with innovative capabilities. Therefore, the efforts of companies to develop radical innovations are related to top managers' and employees' abilities of developing new skills rather than on their past skill and knowledge base (Hermann et al., 2006).

Effective knowledge management has been presented in the literature as one method for improving innovativeness and performance. The term knowledge management is used to denote the practices used by a firm to attain new knowledge, and to reorganize and disperse existing knowledge within the firm. Despite the fact that knowledge management is not alike to innovation, these terms are somehow connected, since innovation can be viewed as the production of new knowledge (Hall and Mairesse, 2006). In particular, knowledge dissemination and responsiveness to knowledge have been mooted as the two components that would have the highest impact on the creation of a sustainable competitive advantage, such as innovations. Lööf and Heshmati's (2002) empirical study inspected how knowledge capital had influenced the firms' performance heterogeneity; and they point out that there is no two-sided relationship between them. Besides, Liao and Chuang (2006) expressed the positive effect of knowledge management over the innovation speed and magnitude, and also the positive relation of innovations over the firms' performance. Briefly, knowledge management and knowledge sharing are essential practices that support and lead innovation

activities. Thus, knowledge management becomes a guiding business application that influences the strategies undertaken by managers within firms.

Souitaris (2002) examined firms' innovative capabilities while categorizing them related to their business strategies. He emphasized that firms those have specialized supplier and investigate more in R&D are found to have higher rate of innovation than supplier dominated firms. Most importantly, different variables proved to be significantly associated with innovations; for instance, innovative capability for supplier dominated firms is related to the competitive environment, acquisition of information, technology strategy, risk attitude and internal coordination. Conversely, for scale intensive firms, innovation success is related to the ability of raising funds and improving the education and experience level of employees. For firms which have specialized suppliers, innovation is associated with high growth rate and exporting as well as training and incentives offered to the employees to contribute towards innovation. Science-based firms are more related to technology-related variables, education and experience of personnel, growth in profitability and panel discussions with lead customers in their innovativeness abilities.

Moreover, Love et al. (1996) studied that entering to import market, technological opportunities and R&D collaboration, the existence of the R&D department in the company all have positive effects over innovativeness of companies. In fact, collaborations and coordination play significant roles in forming companies' innovative capabilities. Sáez et al. (2002) declared innovation as an occasional consequence of collaboration between diverse organizations, such as competitors, customers, suppliers, research centres and universities, all with complementary resources. Tether's (2002) findings indicated that many firms develop new processes, products or services without collaborating for innovation with other organizations. Still, firms, which get involved in R&D and attempt to initiate innovations new

to the market rather than new to the firm, are more likely to commit collaborations and cooperative arrangements for innovation.

2.1.5. Sectoral Conditions and Relations

Successful firms' structure and strategies ought to be correlated auspiciously to its surroundings as well. Companies should observe their external environment in order to develop a well-built innovation culture. Barringer and Bluedorn (1999) stated that beneath strong competition pressure, companies attempt to be more innovative and practical. In fact, general environmental aspects such as market dynamism and competitive intensity affect firms' structure and performance (Miller and Friesen, 1982; Covin and Slevin, 1989; Pelham, 1999). Market dynamism can be described as the rate of changes in competitive conditions associated mostly to customers' demand (Simon et al., 2002). And, competitive intensity is defined as the impact of competition on business environment.

Keizer et al. (2002) suggested that innovativeness is the outcome of a purposely chosen and followed policy. If governmental and/or sectoral institutions want to motivate companies to become and continue to be innovative, they ought to hearten these firms to execute an innovation directed policy. Devoid of such a policy, firms might not be capable to grasp successfully kindled measures.

Terwiesch et al. (1996) explored the impact of market conditions on company success and how market characteristics affect the innovation development performance. They stressed that innovation development performance is more significant in technologically stable and mature industries. Additionally, large firms can notably increase their financial performance through innovations, while the profitability of small companies is driven mostly by the industry conditions. Firms in a competitive environment also seem more likely to engage in innovative activities than other firms (Geroski, 1995).

Regular consultation with customers, use of market research and monitoring of competitors' products and processes are practices also associated with high innovation rates. Contact with raw material suppliers is also useful, since they are a significant source of technical know-how. Moreover, Souitaris (2001) proposed that companies should be geared towards developing international contacts, cooperate with other firms in joint ventures and acquire licenses to be more innovative. Kappel et al. (1999) recommended that alliances are very useful means in unsteady environments to reduce innovation risks and to ascertain enduring market positions.

The importance of the external communication, the acquisition and use of the right and specific information, the barriers to innovation, public regulations and incentives and finally market conditions and competition power are also investigated as determinants of innovation in the literature. It is found that in order to innovate, companies have to look for specific information concerning their products and production processes in their sectors.

Public regulations and incentives encourage firms toward innovative activities, either through government/private institution funding or via tax incentives for R&D expenditures. Jaumotte and Pain (2005) indicated that according to findings of European Community Innovation Survey, public funding has a significant positive correlation to innovativeness level of companies and also positively related to the share of turnover accounted for new products.

2.2. Drivers of Innovativeness Model

Based on the literature that is reviewed in the previous section, one can conclude that the innovativeness in a firm is indeed a joint outcome of factors such as firm characteristics, firm structure, intellectual capital, firm strategies and external conditions. These innovation determinants with all their sub-elements are presented in a model in **Figure 1** and hereinafter referred to as the *drivers of innovativeness model*.

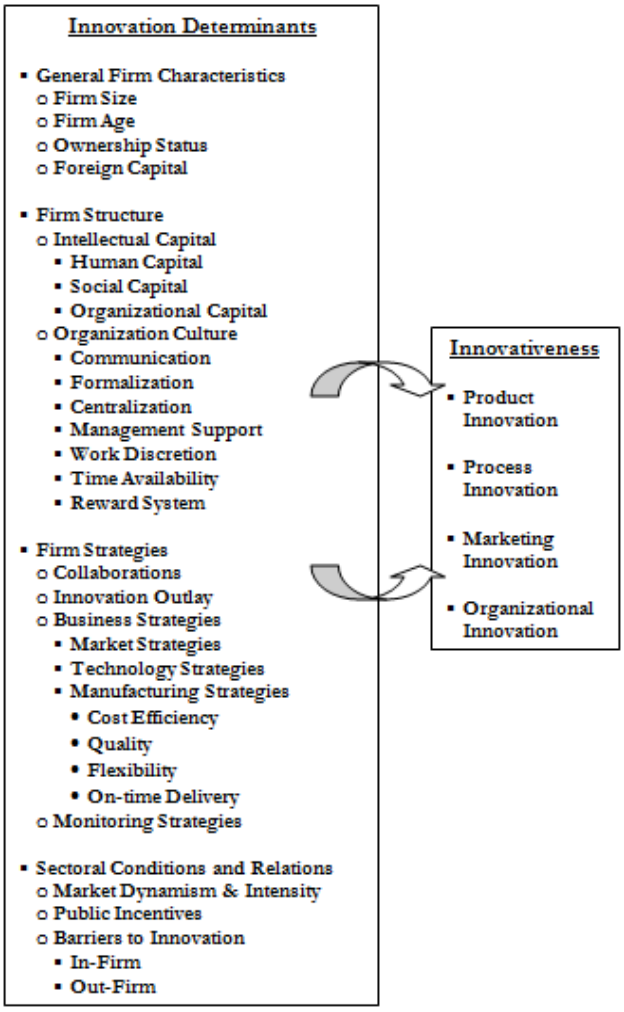

Figure 1 Drivers of Innovativeness Model

One of the main objectives of this research is validating the comprehensive *drivers of innovativeness model* that is presented in Figure 1. For this purpose 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 the firm's general characteristics, firm climate and structure, intellectual capital, business strategies such as the competitive priorities, market and technology strategies, innovativeness efforts, collaborations, monitoring strategies, in-firm environment, market conditions and corporate performance. That is to say, the questionnaire is developed in order to collect the data that is necessary to validate the proposed model. We will next discuss the data collection process and the methodology in more detail.

3. DATA AND METHODOLOGY

3.1. Data Collection

After the questionnaire is developed, 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 using a self-administered questionnaire distributed to firms' upper level managers operating in manufacturing sectors in the Northern Marmara region in Turkey.

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. Out of the sample of 1672 firms, 184 complete responses were obtained resulting in 11% return rate.

The data was later controlled with t-test procedure for non-respondent bias (randomness of the data) and no significant difference ($p \leq 0.05$) was found 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 were examined as control variables, since these organizational variables may have possible effects both on innovative capabilities and firm performance.

Moreover, the issue of Common Method Variance (CMV) was also attended. CMV refers to the amount of spurious covariance shared among variables because of the common method used in collecting the data (Buckley et al., 1990). Harman's single-factor test is arguably the most widely known approach for assessing CMV in a single-method research design (Podsakoff et al. 2003, Podsakoff and Organ, 1986). Typically, in this single-factor test, all of the items in a study are subjected to exploratory factor analysis (EFA). Then, CMV is assumed to exist if (1) a single factor emerges from unrotated factor solutions, or (2) a first factor explains the majority of the variance in the variables (Podsakoff and Organ, 1986). In our case, when we employ EFA for the performance items as well for the innovation items, neither of these two conditions was observed. Hence, one cannot conclude the existence of CMV as a result.

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 2 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.

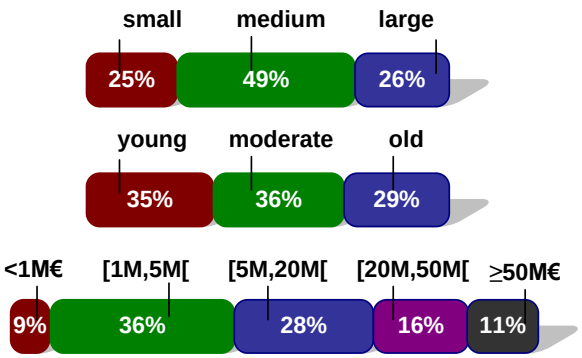

Figure 2 Sample Profile

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. 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 for the human

capital, social capital and organizational capital. 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. (2009). Next, by using the constructs that are obtained after raw sample items (data) were factor analyzed. That is to say, the integrated innovativeness model presented in **Figure 1** is validated 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 1**).

Table 1 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

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 1** demonstrate an acceptable level of overall fit for the proposed model.

Figure 3 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.

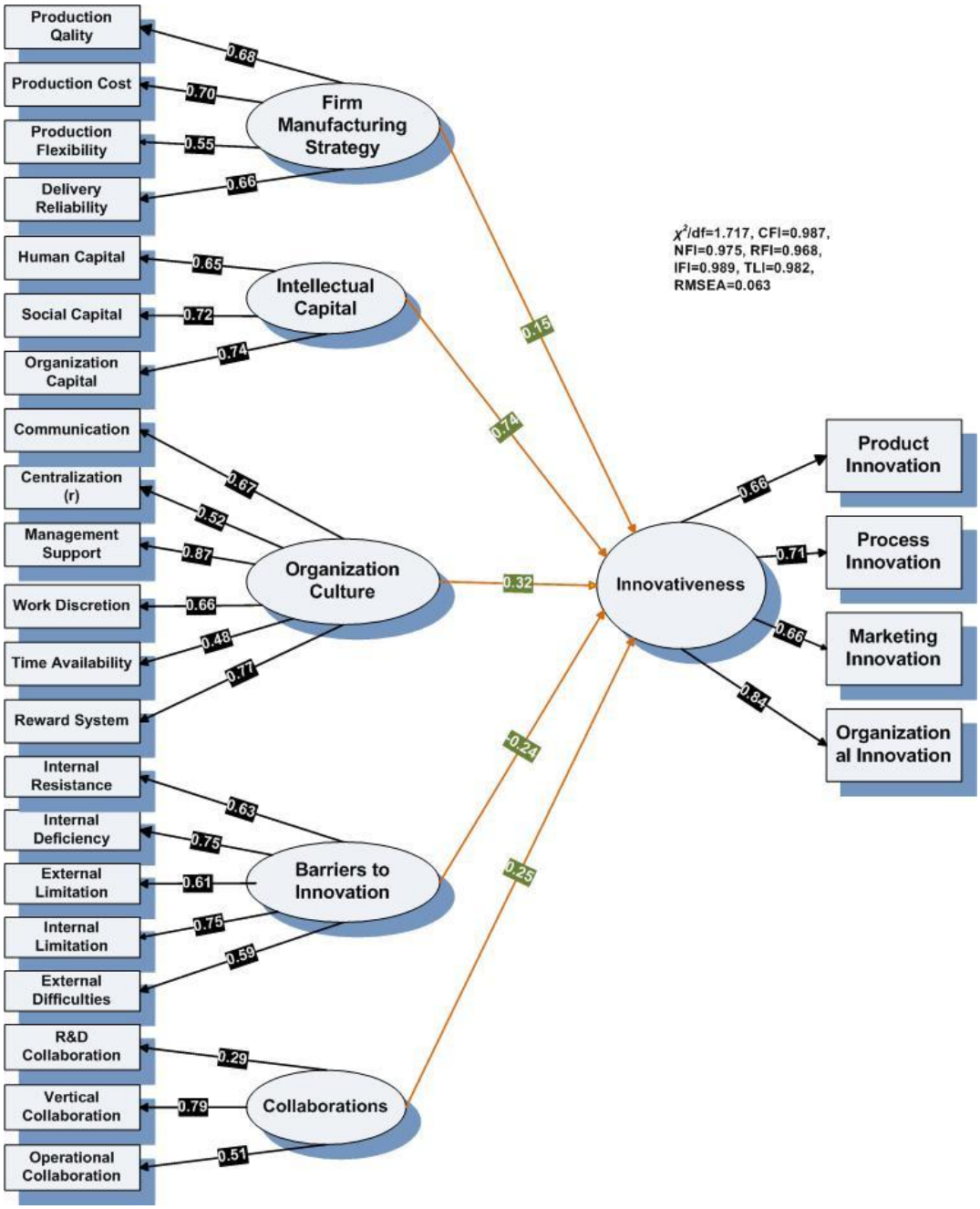

Figure 3 SEM of Drivers of Innovativeness Model

There are some differences between the hypothesized model in **Figure 1** and the model validated with the SEM analysis in **Figure 3**. These are partly due to the results of the factor analysis. For example in **Figure 1**, 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 preferred not 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 and 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.

4.3. Results of the Multiple Linear Regression Analysis

In order to assess the predictive performance of the proposed model in **Figure 1**, 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 2**. 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 3**. The graph demonstrates that the predictive performance of the model is encouraging.

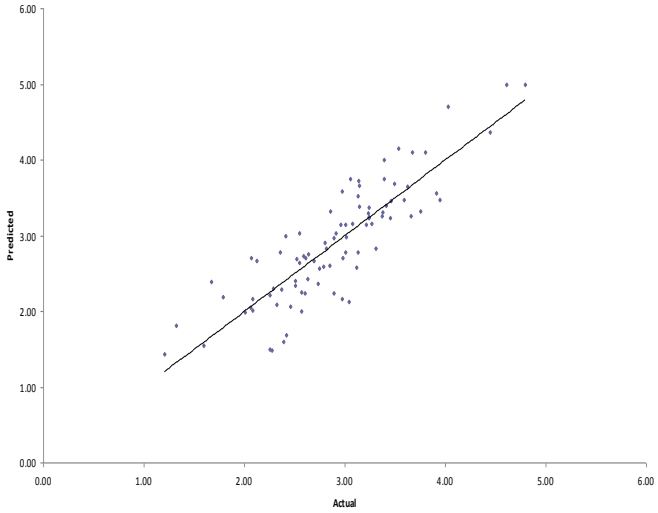

Figure 3 Actual innovativeness vs. the predicted innovativeness based on the MLR model

Table 2 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 $p \leq 0.05$

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. 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 3**).

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.

Table 3 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*		

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

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 2** 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.

6. 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.

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