# A DETERMINANTS OF INNOVATIVENESS MODEL FOR MANUFACTURING FIRMS

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## Abstract

This paper offers a comprehensive model of determinants of innovativeness based on empirical data gathered from 184 manufacturing firms located in the Northern Marmara region in Turkey. As opposed to studies that establish a relationship between a limited set of antecedents and innovativeness, this study allows us to investigate the significance of an antecedent when compared to others. Such invaluable knowledge not only enables decision makers to manage their innovation strategies but also provides a guideline for effective allocation of their limited resources to increase innovation. The analysis reveals that among all possible determinants considered, the highest impact on innovativeness is intellectual capital. This determinant is followed by organizational milieu that consists of the organizational structure and culture components. Path analyses for both of these major innovation determinants are investigated in detail. Some managerial implications are suggested.

## Keywords

Empirical research; Innovation; Determinants of innovativeness model; Intellectual capital; Organizational milieu; Manufacturing industry; Structural equation modelling.

This work has been published in *Int. J. Innovation and Regional Development,* Vol. 6, No. 2, pp. 125-158, 2015. This is the authors' version of that paper published. Changes resulting from the publishing process, such as peer review, editing, corrections, structural formatting, and other quality control mechanisms may not be reflected in this document.

# 1. Introduction

Innovation management literature generally regards effective management of an innovative environment and capabilities within a firm as a means of helping firms achieve higher customer value, thereby leading to a sustainable competitive advantage. Innovativeness at firm level implies here the total innovative capabilities of the firm. With such a perspective, a long list of determinants of innovativeness at the firm level, e.g., organizational culture, intellectual capital, firm strategies, etc., thereby emerge. However, research findings are not always parallel; a determinant found to be effective in one study sometimes proves ineffective in another. Moreover, almost all empirical studies have concentrated on only some specific parts or aspects of this list without controlling for other determinants. There thus appears to be a need in the literature for a comprehensive view. One objective of this research is to fill this gap in innovation literature. Hence, rather than concentrating on one or a few of the possible determinants, a comprehensive view has been taken here. This approach leads to the simultaneous measurement and comparison of the individual effect of different antecedents of innovativeness.

A further objective is to assess the relative contribution of these determinants of innovativeness and hence, to provide decision support to managers when developing their innovation strategies. Indeed the empirical study based on this comprehensive model revealed which of the determinants considered were relatively more important for the creation of an innovative environment in manufacturing firms. The two most outstanding determinants of innovativeness were recognized as intellectual capital and organizational milieu, which are defined here to consist of two components: organizational structure and organizational culture. Path analyses for both of these major determinants are investigated in detail.

In section two, the relevant literature and the comprehensive model will be presented. Section three will cover the details regarding data and measurement of variables. The multivariate data analysis employed in this study will be explained in section four. Following the discussion of the resulting path analysis models for intellectual capital and organizational milieu in sections five and six, respectively, the paper will conclude with managerial implications and further conclusions in section seven.

# 2. Innovation and determinants of innovativeness

Innovation 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. In this research, the OECD Oslo Manual [1], 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: namely, product, process, marketing, and organizational innovations.

The results reported by Günday et al. [2] reveal that innovative companies perform better and are usually more competitive than are their rivals. Some companies turn out to be more successful than the others in innovativeness due to the various internal and external factors they possess. These factors that affect innovativeness (i.e., the innovative capabilities of the companies) are referred to here as the determinants of innovativeness.

## *2.1 The determinants of innovativeness*

The determinants of innovativeness at firm level have been frequently discussed in the innovation management literature. The determinants of innovativeness can be classified in

two subgroups: in-firm (indigenous) determinants and out-firm (exogenous) determinants. The indigenous determinants include general firm characteristics, firm structure (intellectual capital, organizational structure, organizational culture), and firm strategies. On the other hand, exogenous determinants are identified as industrial conditions and relations.

### *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 reveal that foreign affiliations have uncertain effects on innovativeness. For instance, Bishop and Wiseman [3] declare that foreign capital negatively influenced firms' innovative capabilities and R&D functions. Peeters and Van Pottelsberghe [4] examine the innovation competencies and performance of Belgian manufacturing firms. These researchers indicate that foreign firms invested significantly less in R&D than did local firms. However, Love and Ashcroft [5] claim that foreign ownership positively correlates with innovations. Consequently, despite the observation of many studies in the literature that 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 ambiguous affects for a firm's innovativeness abilities. Peeters and Van Pottelsberghe [4] find that large firms were better in terms of innovation competencies. However, according to their study, both large and small firms have more patent applications and R&D investments than do medium sized firms. The authors also stress that the share of turnover due to incremental innovation is higher within small firms, but technological breakthroughs are more vital within large firms. Evangelista et al. [6] study the innovative firms in different manufacturing sectors in Europe investigating the effect of firm size. They find that the percentage of innovativeness was higher for large firms than for smaller ones. They also express the finding that innovation inputs such as R&D investments strongly correlate to firm size, and differ seriously across industries with little change across countries. Love and Ashcroft [5] also claim that the plant size positively correlates with innovations. Camison-Zornoza et al.[7] verify the existence of a significant and positive correlation between size and innovativeness. On the other hand, Lööf and Hesmati [8] investigate the effect of firm size to R&D expenditure by using an econometric model. The authors find that if industry is controlled, innovation intensity is not constant but falls significantly with size. Similarly, Bound et al.[9], basing 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 the size of R&D programs.

Concerning the influence of a firm's age on innovativeness, there are different views presented in the literature. For example, Hansen [10] claim that older firms have the experience to innovate, whereas Sorenson [11] concludes that the so called experience acts as a barrier to introduce new ideas and hence, is inversely proportional with innovativeness. Yet others state that firm age has no impact on innovativeness[12]. There are also some researchers who maintain that firm age differently impacts different types of innovations. Avermaete et al. [13] claim that the impact of the firm age indeed is somewhat ambiguous. As a result of their analysis, they conclude that older firms are more likely to introduce products that are also new to the market segment in which they compete, whereas young firms tend to introduce innovations that have a larger impact on the firm's turnover.

George et al. [14] conclude 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 reveal that companies that are owned internally (by the CEO and other senior managers, etc.) tend to

be more risk averse than those that are externally owned (venture capitalists, institutional investors, etc.). Tribo et al. [15] use data from 3638 Spanish firms and analyse the relationship between the type and number of shareholders and the R&D activities. Their result shows that the impact of large shareholders to R&D investment is negative, if the large shareholder is a bank; positive, if it is a nonfinancial corporation; and neutral, if it is an individual.

### *2.1.2. 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 [16]. 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 [17, 18]. The social capital is the knowledge embedded within, available through and utilized by interactions among individuals and their networks of interrelationships [19]. Organizational capital is the institutionalized knowledge and codified experience residing within and utilized through databases, patents, manuals, structures, systems, and processes [20].

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 [21] examine the importance of intellectual capital of a company in term of its effect on innovative capabilities. The authors find that intellectual capital selectively influences incremental and radical innovative capabilities. They state 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 plays a noteworthy role in both types of innovation, as it positively affects both incremental and radical innovations.

Cohen and Levinthal [22] stress that the human capital of a firm has a vital role for innovativeness, as it provides the ability to obtain and use the outcomes of other firms' R&D activities. Cohen and Levinthal [23] introduce the concept of absorptive capacity and describe it as the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends, which they see as largely a function of the firm's level of prior related knowledge. Zahra and George [24] elaborate on the different processes associated with absorptive capacity: search, acquisition, assimilation and exploitation of new knowledge. Obviously connectivity between them is important. The ability to search and acquire might not lead to innovation. Vinding [25] reports as a result of an empirical study conducted in Denmark covering 1544 firms that firms that have educated a large share of their employees are more probable to launch radical innovative products or processes (radical meaning here new to the world) and emphasize the importance of human capital for the firms' absorptive capacity. Also, Hall and Mairesse [26] indicate that a great deal of the knowledge created by firm activities is to some extent embedded in its human capital.

Landry et al. [27] examine the role of social capital on innovation decisions. Data collected from 440 manufacturing firms in Quebec reveal that diverse forms of social capital influence innovation decisions and an increase in social capital increases the likeliness of innovation. Ruuskanen [28] analyses data collected from Finnish SME's and demonstrates that social capital significantly correlates statistically with the overall innovation activities of the firms. He proposes that social capital enhances innovations through knowledge spillovers.

### *2.1.3. Organizational structure and culture*

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 [29]. The 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 ([30], [31], [32]). Innovative capability of a firm thrives when this conversion process is instilled in firms' business methods, practices, strategies and efforts ([33], [34]).

A suitable environment 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 of 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 ([31], [32],[34], [35], [36], [37], [38]). In this respect, encouragement of new idea generation and development is expected 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 [39]. 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., [29], [30]) since most of the enthusiastic intrapreneurs make their pioneering steps to actualize their idealized projects in their spare time [40].

Moreover, autonomous work arrangements such as work discretion i.e., ability to take initiative in decision making and planning flexibility, i.e., the ability to revise plans in order 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.,[41], [42]). Additionally, if the employees have a high level of trust in the reward system of their organization and also feel free from 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., [43], [44]).

Increasingly, studies stress organizational culture as a key to managing innovation [45] Martins and Terblanche [46] investigate the determinants of organizational culture, which influence creativity and innovation. The determinants of organizational culture were identified. The determinants are found as strategy, structure, support mechanisms, behaviour that encourages innovation, and open communication.

An empirical work conducted in SMEs concludes that managerial support and reward system support are both positively related to an innovative organizational culture whereas perceived work overload is negatively related. Companies with cultures supportive of innovation tend to be smaller and have fewer formalized human resource practices [47].

In investigating 759 firms across 17 major economies of the world using survey and archival data it is concluded that among the factors studied, corporate culture is the strongest driver of radical innovation across nations [48].

Claver et al. [49] investigate the interaction of organizational behaviour with technological innovation and stress, to identify among others, the importance of teamwork, autonomy, initiative, and decentralized organizational structure on technological innovation.

Naranjo-Valencia et al. [50] base an empirical study covering 471 Spanish companies to conclude that organizational culture is one of the determinants of supporting an innovative orientation within the organization and that organizational culture is a clear determinant of innovation orientation. A further result they present is that decentralized cultures foster innovation orientation whereas hierarchical cultures promote imitative cultures.

Jassawalla and Sashittal [51] report that highly innovation-supportive cultures are credited with fostering teamwork and promoting risk-taking and creative actions that seem directly linked to effective new-product development, i.e., product innovation.

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 [52] argues that innovation requires low formalization and centralization, but higher levels of internal communication. Accordingly an organic structure fosters innovation 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 ([53], [54]).

### *2.1.4. Firm Strategies*

The innovative capability of a company depends on many factors including understanding 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. Furthermore, Loch et al. [55] express 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 [56] investigate the statistical effects of business strategies in term of innovative performance. The research indicates 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. [57] show 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 [58] analyze the relation between innovativeness and the export performance at firm level. They find that innovative firms are exporting more and that product innovation has a strong effect on the probability and propensity to export. Similarly, Geroski [59] propose 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 [58] point out 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 stress that innovativeness and success in product innovation both have positive effects on exports.

Darroch and Mcnaughton [60] show 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 add 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 determinants of innovativeness discussed in the literature ([61], [62]). Galende and De la Fuente [61] observethat the differentiation technique definitely positively impacts upon the innovative capability of a company. Hitt et al.[64]show 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 a 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 relate to top managers' and employees' abilities of developing new skills rather than relying on their past skill and knowledge base [65].

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 [66]. In particular, knowledge dissemination and responsiveness to knowledge have been proposed 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 [8] empirical study inspects how knowledge capital had influenced the firms' performance heterogeneity; and they point out that between these variables no two-sided relationship exists. Besides, Liao and Chuang [67] express 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 [68] examines firms' innovative capabilities while categorizing them in relation to their business strategies. He emphasizes that firms that have a specialized supplier and investigate more in R&D are found to have higher rate of innovation than supplier dominated firms. Most importantly, different variables prove to be significantly associated with innovations; for instance, innovative capability for supplier-dominated firms relates 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. [69] study the phenomena that in entering the 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. [70] declare 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 [71] findings indicate that many firms develop new processes, products or services without collaborating for innovation with other organizations. Nevertheless, firms, involved in R&D and attempting

to initiate innovations new to the market rather than new to the firm, are more likely to commit to 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 [73] state 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 ([73], [74], [75]). Market dynamism can be described as the rate of change in competitive conditions associated mostly to customers' demand ([74]) and competitive intensity as the impact of competition on business environment.

Keizer et al. [77] suggest 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. [78] explore the impact of market conditions on company success and how market characteristics affect the innovation development performance. They stress 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 [59].

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 [68] proposes 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. [79] recommend that alliances are very useful means in unsteady environments to reduce innovation risks and to ascertain enduring market positions.

The importance of external communication, the acquisition and use of appropriate 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 [80] indicate that according to the findings of the European Community Innovation Survey, public funding has a significant positive correlation to the innovativeness level of companies and is also positively related to the share of turnover accounted by new products.

## *2.2 The determinants of innovativeness model*

Based on the literature review in the previous section, one can conclude that the innovativeness in a firm is indeed a joint outcome of factors such as firm characteristics, intellectual capital, organizational milieu, firm strategies and external conditions. These innovation determinants with all their sub-elements are presented in a model designated as the determinants of innovativeness model (Figure 1).

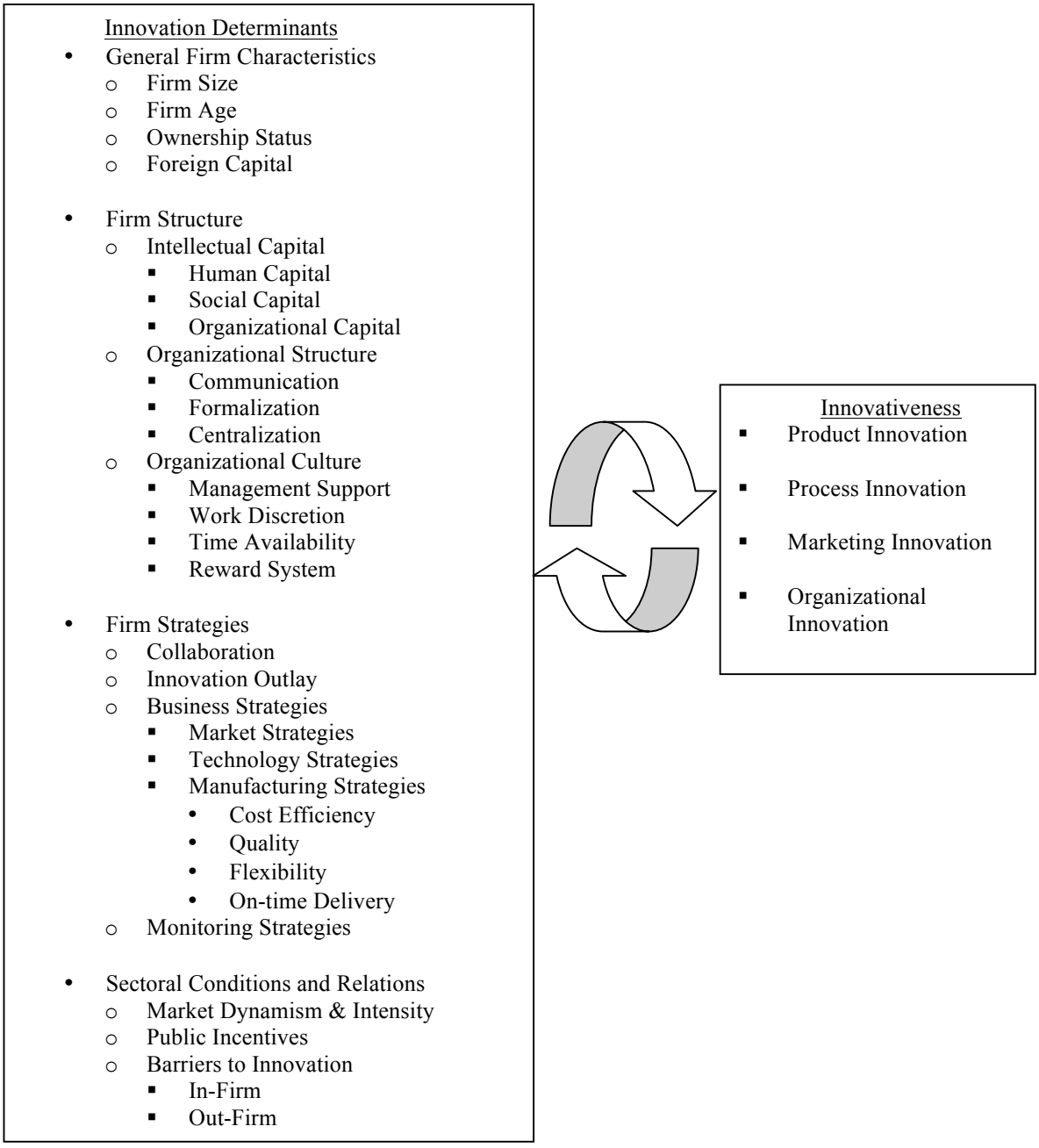


**Figure 1** Determinants of innovativeness model.

We will next discuss the data collection process and methodology in more detail.

## 3. Empirical study

In order to validate the determinants of innovativeness model, a questionnaire consisting of 311 individual questions was developed. The questionnaire was completed by the upper managers of manufacturing companies. The resulting initial survey draft was discussed with various firms' executives and pre-tested through 10 pilot interviews to ensure that the wording, format and sequencing of questions are appropriate. The questions (variables), which take part in the factor analyses, can be accessed from [81].

### *3.1 Data collection*

A sample of 1,674 manufacturing firms was obtained by random selection from the database of the Union of Chambers and Commodity Exchange (TOBB),Istanbul, Kocaeli, Tekirdag, Cerkezkoy, and Sakarya Industry Chambers, and member lists of various Industry Parks in the 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. Data was collected over a 7 month period in six different manufacturing sectors (namely textile (20%), chemical (18%), metal products (19%), machinery (15%), domestic appliances (8%) and automotive industries (20%)), where the percentages reported correspond to the percentage of the firms surveyed in each sector within the total sample. For each sector, the number of firms in the sample emerged as 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. From the sample of 1672 firms, 184 complete responses were obtained resulting in a 11% return rate. The percentage of missing data across all data was calculated to be negligible. Occasional missing data were randomly distributed (MAR) on items. All respondents completing the questionnaire were from the top (52%) or middle management (48%).

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 addressed, based on Harman's single-factor test, which demonstrates that one cannot conclude as a result the existence of CMV.

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 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.

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.

### *3.2 Measurement of variables*

The preparation of the questionnaire form takes into account recent questionnaire forms used in similar studies and commonly accepted measures met in the current literature. Specifically, questions are raised regarding manufacturing strategies (operations priorities), organizational milieu, innovation barriers, intellectual capital, business strategies using a 5-point Likert scale to inquire the importance the firm awards to each item in a scale ranging from 1=extremely unimportant to 5=extremely important. For the marketing and technology strategies, on the other hand, again a 5-point Likert scale is employed but this time with various different designations for the scales such as 1=no resources allocated to 5=all resources allocated. Such subjective measures possibly bring in manager bias but are widespread practice in empirical research [45].

The scales of the four different manufacturing strategies' measures are adapted from existing operations management (OM) literature in six, six, seven, and six criteria, respectively. The base of items asked regarding these priorities are adapted mainly from Boyer and Lewis [82], Alpkan et al. [83], Noble [84], Ward et al. [85], Vickery et al. [86] and Kathuria [87]. We also benefited from Olson et al. [88] for business strategy items.

The scales of the three intellectual capital measures are inspired by Subramaniam and Youndt [21] with five, five, and four criteria, respectively for the human capital, social capital and organizational capital. Similarly, organizational structure and culture measures are adapted from several criteria in OM literature based on previous studies of Walker et al. [89], Jaworski and Kohli [90] and Menon et al. [91].

The questions about innovativeness (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'. Note that the questions require the consideration of the last three years. Any period shorter would be too short for policies to take root. Longer periods, on the other hand, might be too long for the respondent to compose a succinct answer. The base of items regarding these capabilities is adapted mainly from the Oslo Manual [1] concerning product, process, marketing, and organizational innovations. Innovativeness is then measured as the combination of these four innovation constructs. 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 require validation during the analysis.

On the other hand, some of the determinants of innovativeness such as 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).

## 4. Multivariate data analysis

In order to extract the underlying relationships between the determinants of innovativeness and innovativeness, a multivariate data analysis is conducted. First, a principal component analysis (PCA) with varimax rotation is applied using SPPS in order to identify the underlying determinants of innovativeness and their dimensions, which was followed by a second order PCA in order to reduce the obtained items to usable size and to achieve a more manageable set for subsequent structural equations modelling analysis (SEM). Five constructs for determinants of innovativeness were obtained; namely, organizational milieu, barriers to innovation, firm manufacturing strategy, intellectual capital, and collaboration. This stage is concluded by exploring internal consistency and reliability (content validity) among the items of each construct via Cronbach α ([92]) and unidimensionality tests. Cronbach α values ≥ 0.7 suggest a satisfactory level of construct reliability ([93], [94]). Moreover, convergent validity between the constructs is also examined and verified by the average-variance extracted (AVE) test, with its value equal to the square root of average communalities of items on that factor [95]. Note that, a compelling demonstration of convergent validity would be an AVE score of 0.5 or above ([95],[96]).

The second stage involved the analysis of the relationships between the factors explored through the correlation and regression analyses and SEM. The 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 was conducted by AMOS v16. The measurement model of SEM is based on the comparison of the variance-covariance matrix obtained from the sample to the one obtained from the model [97]. The entire model is supported with the goodness-of-fit indices (Table 1). These indices conform to the acceptable standards with the value of $\chi 2/df$ ratio of 1.717. This ratio establishes the appropriateness of the model and should be within the

range of 1-5, where lower values indicate a better fit [98]. The goodness-of-fit indices exhibited in Table 1 demonstrate an acceptable level of overall fit for the proposed model.

**Table 1** SEM Goodness of fit indices.

| **Goodness of fit indices** | **Construct Performance** | *Reference value* |
|---|---|---|
| $\chi^2$ / 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 |

Figure 2 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 determinants of innovativeness 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. Intellectual capital is followed by organizational milieu, collaborations, barriers to innovation, and firm manufacturing strategies. Among the factors of organizational milieu, management support and reward system have the highest regression estimates.

Furthermore, it is found that determinants of innovativeness, namely intellectual capital, organizational milieu, firm manufacturing strategy, and collaborations all positively impact upon innovativeness while innovation barriers have negative impacts. There is no controversy with this expected result based on the existing literature.

There are some differences between the theoretical model in Figure 1 and the model validated with the SEM analysis in Figure 2. These divergences are partly due to the results of the factor analysis. For example in Figure 1, we hypothesized that intellectual capital, organizational structure and culture are subparts of another construct, referred to here as the firm structure. However, the factor analysis results imply that the items composing 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 organizational structure. However, the factor analysis misplaced formalization under the intellectual capital construct so we decided to eliminate it in the SEM analysis.

Due to the nature of their scales, general firm characteristics, innovation outlay, as well as marketing and technology strategies were not included in 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 on innovativeness at the firm level. Finally, some of the constructs such as public incentives, market dynamism and intensity as well as monitoring strategies were excluded from the SEM analysis since they were deteriorating the underlying factor structure.

In the following section, we will report the results of the path analyses leading to path models for intellectual capital and organizational milieu--the two most effective drivers of innovative capabilities.

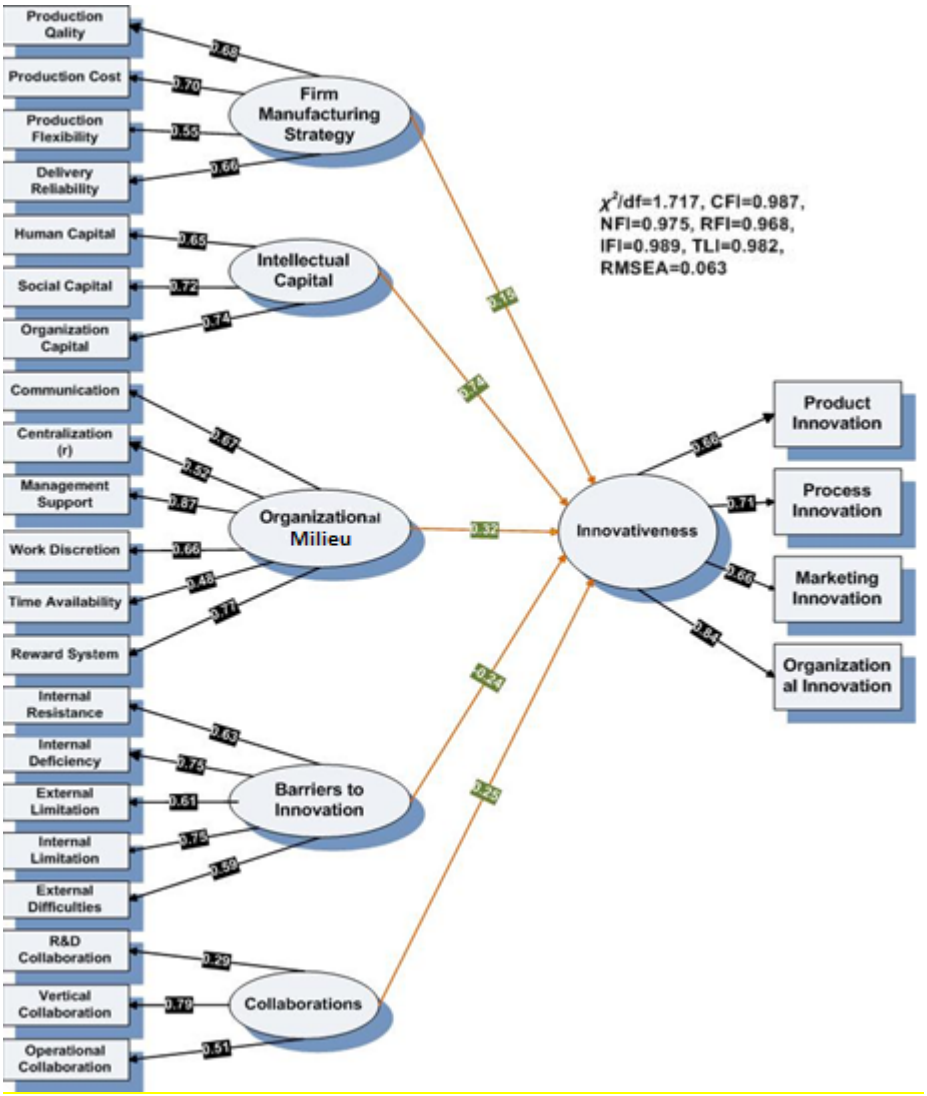


**Figure 2** Determinants of the innovativeness model resulting from the SEM analysis.

The path analysis models in the following section have a common endogenous variable (dependent variable): innovativeness. The models are formed employing AMOS v4.0 and analyzed according to the SEM method. In the figures displaying these path models, the estimates on the arrows are regression weights and the estimates on the box corners are the squared multiple correlations.

## 5. Intellectual capital

According to exploratory factor analysis (EFA) applied with SPSS, the extracted factor structure of firm intellectual capital can be seen in Table 2. For this analysis, 14 intellectual capital questions in the survey (see Appendix A) are placed together into PCA, and four latent factors are extracted. There are not any items that spoiled the factor structure. The obtained factors are human capital, social capital, and organizational capital.

The outcome of EFA shows that all the variables in the survey are placed under expected factors. Still, in order to test the factor structure, a single-step confirmatory factor analysis (CFA) is conducted for the intellectual capital factors. All the factor loadings but two (i.e., e9, e11) have high (>0.50) and significant ($p<0.05$) loadings. Still, those three items are also retained since their factor loadings are also reasonably high and significant ($p<0.05$). Additionally, reliability analysis will show that they are reliable items.

**Table 2** Factor structure of intellectual capital.

| | | Factors | | |
|---|---|---|---|---|
| | **Questions** | **1** | **2** | **3** |
| Human capital | e1 | 0.832 | | |
| | e3 | 0.804 | | |
| | e5 | 0.680 | | |
| | e2 | 0.636 | | |
| | e4 | 0.570 | | |
| Social capital | e8 | | 0.775 | |
| | e7 | | 0.767 | |
| | e6 | | 0.635 | |
| | e9 | | 0.559 | |
| | e10 | | 0.470 | |
| Organizational capital | e14 | | | 0.810 |
| | e13 | | | 0.759 |
| | e12 | | | 0.735 |
| | e11 | | | 0.536 |
| Total variance explained: 58.493% | | | | |

The results of this analysis are evaluated by the goodness of fit indices. These indices are shown in Table 3.The overall fit statistics for the model demonstrates an acceptance level for the intellectual capital factor structure. Therefore, the factors are consistent and valid.

As a result of EFA and CFA, intellectual capital is represented by three factors, namely human capital, social capital, and organizational capital.

For the reliability of these factors, Cronbach α method is used. Reliability analysis shows that all the factors are internally consistent and reliable since all Cronbach α values are greater than 0.60.

**Table 3** Goodness of fit indices of CFA for intellectual capital.

| **Goodness of Fit Indices** | **Findings** | **Reference Value** |
|---|---|---|
| | **Intellectual Capital** | |
| $\chi^2$ / degrees of freedom | 1.719 | $1<\chi^2 / df<5$ |
| CFI (Comparative Fit Index) | 0.990 | 0.9<CFI<1 |
| NFI (Normed Fit Index) | 0.977 | 0.9<NFI<1 |
| RFI (Relative Fit Index) | 0.970 | 0.9<RFI<1 |
| IFI (Incremental Fit Index) | 0.990 | 0.9<IFI<1 |
| TLI (Tucker-Lewis Fit Index) | 0.987 | 0.9<TLI<1 |
| RMSEA (Root Mean Square Error) | 0.065 | RMSEA<0.08 |

After the reliabilities of the intellectual capital scales are tested and approved, a correlation analysis inspects the one-to-one relationship between innovativeness and intellectual capital factors. Results are shown in Table 4 with the mean values of the intellectual capital factors, where scale 1 indicates very low, 2=low, 3= mediocre, 4=high and 5=very high. The findings of this analysis give information similar to the linear regression between two factors. The mean value of innovativeness, on the other hand, is obtained using the scale given in section 3.2. It is determined as 2.81, which implies that imitation both from national and international markets is the prevalent strategy for the manufacturing firms studied.

**Table 4** Correlation analysis of intellectual capital.

| | Mean | Std Dev | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|
| 1. Innovativeness | 2.81 | 0.84 | 1 | 0.295** | 0.271** | 0.518** |
| 2. Human capital | 3.62 | 0.65 | | 1 | 0.582** | 0.389** |
| 3. Social capital | 3.65 | 0.59 | | | 1 | 0.498** |
| 4. Organizational capital | 3.41 | 0.88 | | | | 1 |

(**) p<0.01

Considering the descriptive statistics and means of the intellectual capital factors, it is seen that firms in our sample employ relatively good and creative employees. The high social capital also indicates that learning from colleagues and employees' capabilities for problem solving are prevalent in the companies. However, relatively low organizational capital is a sign that firms have difficulties in transforming their human and social capital into organizational capital.

The findings of the correlation analysis extract a significant one-to-one positive relationship of the aggregated factors. All intellectual capital factors correlate significantly to the innovativeness scale with p<.01. Organizational capital has higher correlation coefficient (r:0.518), and specialization has lower correlation coefficient (r:0.206). Very high correlation of organizational capital stresses the major importance of this factor for firms in order to be more innovative.

Briefly, correlation analysis brings up the positive relationship between innovativeness and intellectual capital. However, this analysis cannot say much about the direction (cause) of the relationship. For that purpose, the multiple regression analysis can provide more insight.

The regression model of the effects of intellectual capital on innovativeness is statistically significant (p<0.01), and according to this model, the independent variables express 28.0% ($r^2$=0.280) of innovativeness. It is useful to note that the high $r^2$ of the model and high regression coefficient of organizational capital indicate that intellectual capital and especially organizational capital have supreme importance for innovative capability.

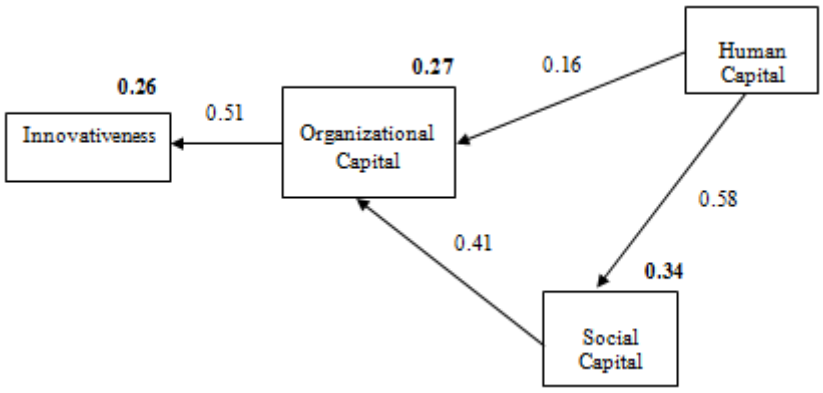


**Figure 3** Path analysis model for intellectual capital.

However, when the factors are included jointly in the multiple linear regression, only organizational capital (β=0.495; p<0.01) and human capital (β=0.144; p<0.1) have significant positive effects. On the other hand, when entered separately, all intellectual capital factors are significantly and positively correlated to innovativeness. So, despite the fact that the model is significant, multiple linear regression analysis reveals only some intellectual capital factors have statistically significant effects on innovativeness. This finding implies that there are mediating effects between intellectual capital variables. In such cases, it is necessary to

carry on the multiple regression analysis of innovative performance by SEM and path analysis in order to expose the direction of mediation effects.

Post hoc analysis suggests that the effect of social capital on innovativeness is mediated by organization and human capital. Therefore, a path analysis model for intellectual capital is formed by AMOS v4.0 and analyzed according to the SEM method. The resulting path analysis model with its significantly consistent findings is displayed in Figure 3. The model can explain 26% of the innovativeness.

**Table 5** Factor structure of the organizational milieu.

| | Questions | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| Management support | k22 | 0.740 | | | | | | |
| | k20 | 0.726 | | | | | | |
| | k21 | 0.684 | | | | | | |
| | k23 | 0.650 | | | | | | |
| | k24 | 0.629 | | | | | | |
| | k30 | 0.620 | | | | | | |
| | k28 | 0.565 | | | | | | |
| | k25 | 0.562 | | | | | | |
| | k26 | 0.554 | | | | | | |
| | k29 | 0.455 | | | | | | |
| | k27 | 0.442 | | | | | | |
| Reward system | k40 | | 0.805 | | | | | |
| | k44 | | 0.795 | | | | | |
| | k43 | | 0.768 | | | | | |
| | k42 | | 0.761 | | | | | |
| | k41 | | 0.734 | | | | | |
| Centralisation | k18 | | | 0.778 | | | | |
| | k17 | | | 0.752 | | | | |
| | k19 | | | 0.750 | | | | |
| | k16 | | | 0.749 | | | | |
| | k14 | | | 0.629 | | | | |
| | k15 | | | 0.613 | | | | |
| Formalisation | k11 | | | | 0.713 | | | |
| | k10 | | | | 0.666 | | | |
| | k12 | | | | 0.631 | | | |
| | k8 | | | | 0.611 | | | |
| | k13 | | | | 0.607 | | | |
| | k9 | | | | 0.471 | | | |
| Communication | k6 | | | | | 0.696 | | |
| | k5 | | | | | 0.647 | | |
| | k4 | | | | | 0.638 | | |
| | k3 | | | | | 0.619 | | |
| | k7 | | | | | 0.589 | | |
| Work discretion | k38 | | | | | | 0.826 | |
| | k39 | | | | | | 0.817 | |
| | k37 | | | | | | 0.725 | |
| Time availability | k35 | | | | | | | 0.724 |
| | k34 | | | | | | | 0.703 |
| | k32 | | | | | | | 0.623 |
| | k31 | | | | | | | 0.507 |
| Total variance explained: 62.774% | | | | | | | | |

## 6. Organizational milieu

The extracted factor structure of organizational milieu is reported in Table 5 as obtained through EFA. There are 44 questions in the organizational structure and culture sections of the survey are reported in Appendix B. For this analysis, all organizational milieu questions in the survey are placed together in the PCA, and seven latent factors are extracted. There is

not any item that spoiled the factor structure. The factors obtained are coined as communication, formalization, centralization, management support, time availability, work discretion, and reward system.

The result of EFA shows that all the variables in the survey are placed under expected factors. However, CFA is necessary in order to test the factors structure. A single-step CFA is conducted for the organizational milieu. All the factor loadings but four (i.e., k25, k10, k12, k7) have high (>0.50) and significant ($p<0.05$) loadings. Still, those four items are also retained since their factor loadings are also reasonably high and significant ($p<0.05$). Additionally, reliability analysis will show that they are reliable scales.

The results of this analysis are evaluated by the goodness of fit indices. These indices are shown in Table 6.CFA is performed in order to evaluate the measurement properties of the EFA. The overall fit statistics for the model demonstrate an acceptance level for organizational milieu factor structure. Therefore, the factors are consistent and valid.

**Table 6** Goodness of fit indices of the CFA for the organizational milieu.

| Goodness of Fit Indices | Findings | Reference Value |
|---|---|---|
| | Organizational Milieu | |
| $\chi^2$ / degrees of freedom | 1.869 | $1<\chi^2/df<5$ |
| CFI (Comparative Fit Index) | 0.970 | 0.9<CFI<1 |
| NFI (Normed Fit Index) | 0.938 | 0.9<NFI<1 |
| RFI (Relative Fit Index) | 0.929 | 0.9<RFI<1 |
| IFI (Incremental Fit Index) | 0.970 | 0.9<IFI<1 |
| TLI (Tucker-Lewis Fit Index) | 0.966 | 0.9<TLI<1 |
| RMSEA (Root Mean Square Error) | 0.072 | RMSEA<.08 |

As a result of the EFA and CFA, organizational milieu is found to consist of seven factors, namely, communication, formalization, centralization, management support, time availability, work discretion, and reward system.

For the reliability of the factors, Cronbach α method is used. Reliability analysis shows that all the factors are internally consistent and reliable since all α values are greater than 0.70.

After reliabilities of the organizational milieu scales' are tested and approved, correlation analysis is performed in order to inspect one-to-one relationship between the innovativeness and organizational milieu factors. Table 7 illustrates the results of the correlation analysis and means of the factors using the same scale as the one for the intellectual capital factors.

**Table 7** Correlation analysis of organizational milieu.

| | Mean | Std Dev | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Innovativeness | 2.81 | 0.84 | 1 | .350** | .155* | -.192* | .382** | .226** | .219** | .340** |
| 2. Communication | 3.95 | 0.63 | | 1 | .293** | -.434** | .572** | .402** | .225*** | .524** |
| 3. Formalization | 3.39 | 0.70 | | | 1 | -.081 | .321** | .029 | .265** | .218** |
| 4. Centralization | 2.79 | 0.82 | | | | 1 | -.450** | -.332** | -.144 | -.357** |
| 5.Management support | 3.53 | 0.68 | | | | | 1 | .476** | .386** | .673** |
| 6. Work discretion | 3.23 | 0.75 | | | | | | 1 | .381** | .419** |
| 7.Time availability | 3.21 | 0.94 | | | | | | | 1 | .405** |
| 8. Reward system | 3.68 | 0.93 | | | | | | | | 1 |

(**) p<0.01; (*) p,0.05

The amount of variance between variables is convenient for further statistical analyses since factors' standard deviations are between 0.63 and 0.94. In Table 7, all the factors are significantly positively correlated to innovativeness except the centralization factor, which is significantly negatively correlated to innovativeness as expected. It is understood that providing higher authority and responsibilities to middle level managers facilitates the innovation process in companies. Consequently, the positive correlation between innovativeness and organizational milieu supports the determinants of innovativeness model.

According to the descriptive statistics and means of the organizational milieu, companies primarily give importance to the communication and reward system. In contrast, they attach less importance to work discretion and time availability issues. Moreover, companies appear to be rather centralized.

The findings of the correlation analysis extract a significant one-to-one positive relationship of the aggregated factors. All organizational milieu factors correlate significantly to innovativeness scale with $p<0.01$ except formalization and centralization whose correlations are at $\alpha=95\%$ level. Management support has a higher correlation coefficient (r:0.382) and formalization has a lower correlation coefficient (r:0.155) with innovativeness. The high correlation of management support stresses the major importance of managerial encouragement to idea generation and support to new projects in order to be more innovative. Briefly, correlation analysis brings up the positive relationship between innovativeness and organizational milieu. However, this analysis cannot say much about the direction (cause) of the relationship. For that purpose, the multiple linear regression analysis can give more insight.

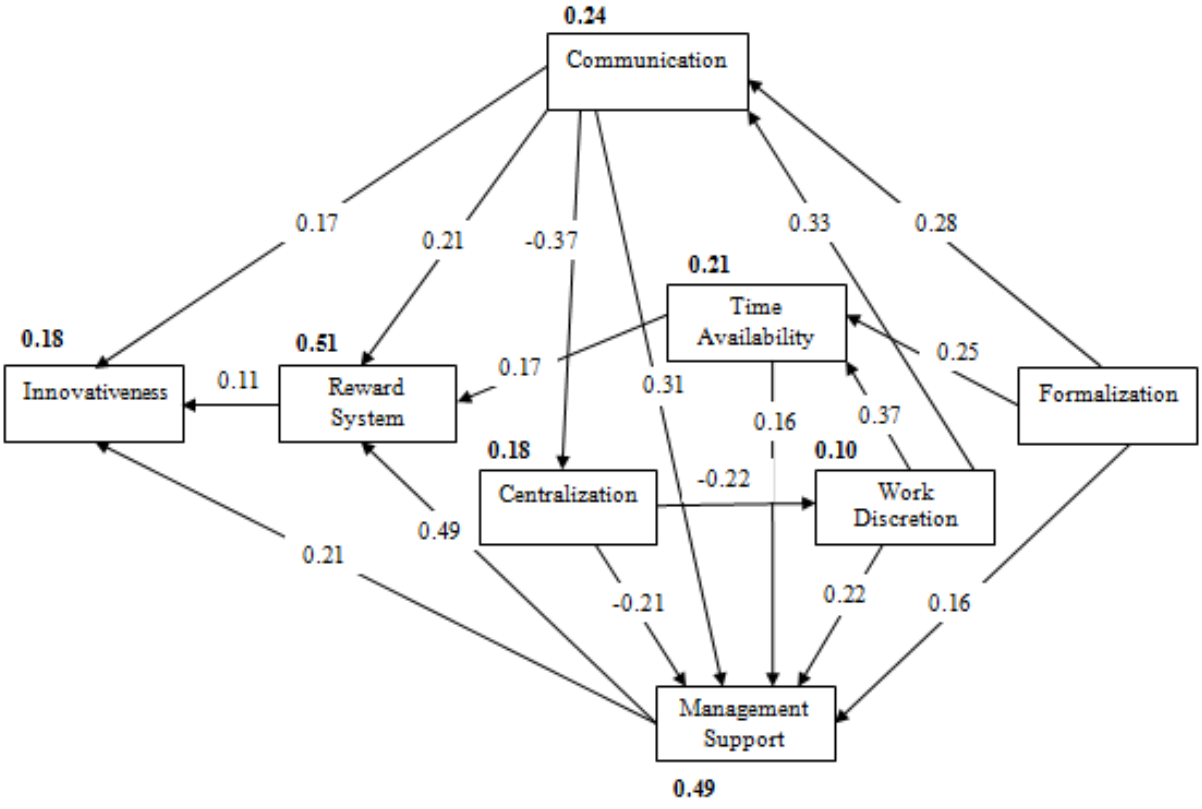


**Figure 4** Path analysis model for organizational milieu.

The regression model investigating the effects of organizational milieu on innovativeness is statistically significant ($p<0.01$); according to this model, the independent variables express 18.3% ($r^2=0.183$) of innovativeness. However, when organizational milieu factors are included jointly in the MLR, only communication ($\beta=0.181$; $p=0.058$) and management

support (β=0.195; p=0.082) have significant positive effects on innovativeness. But when included individually, all organizational milieu factors were significantly and positively correlated to innovativeness. Therefore, despite the fact that the model is significant, there is a mediating effect between the organizational milieu factors.

Post hoc analysis suggests that communication and management support mediated other organizational milieu factor effects on innovativeness. A path analysis model for organizational milieu is formed by AMOS v4.0 and analyzed according to the SME method. Figure 4 presents this model with its significantly consistent findings. The model can explain18% of innovativeness.

As mentioned above, centralization is negatively correlated to innovativeness as well as all the other factors. The path analysis model in Figure 5 also shows that the more centralized an organization, the less opportunity employees have for exercising initiative and hence, blocking the way to new approaches and innovation. It has a similar effect through decreased top management support for new ideas, projects and risk taking behaviour of the employees. Communication appears to act as an antidote to centralization.

## 7. Results and conclusions

This paper reports on an innovativeness study in the Turkish manufacturing industry, drawing on a sample of 184 manufacturing firms. A framework has been empirically tested identifying the relationships among innovativeness and a comprehensive list of determinants of innovativeness. As mentioned earlier, almost all empirical studies focused on one or a few of possible determinants. Hence, there is a gap in the literature for a comprehensive view when investigating these relations. This paper not only helps to fill this gap in the related literature but the results obtained can be utilized to assist top management for developing innovation policies and strategy.

*General firm characteristics*. Recall that general firm characteristic variables, which were included in the theoretical 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 significantly correlated with innovativeness. As previously stated, employee numbers were used as a measure of the firm size. The relationship between the firm size and innovativeness was found to be almost linear. One-way ANOVA analysis for the innovativeness level of small, medium and large firms was conducted. Findings report that innovativeness levels of these three groups significantly differ ($p<0.05$) and large- and medium-size firms are performing better than the small-size firms in implementing innovations. Large-sized firms 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-wise, small and medium size firms demonstrate weak results for patent applications, collaborations, use of public incentives, and R&D investments. It is observed that manufacturing firms currently are mostly in the stage of imitation of national and international markets. This strategy is no longer sustainable when considering global competition. In order to survive and thrive, top management needs to improve the firm's absorptive capacity as well as emphasize R&D and technology management.

*Intellectual capital*. Human capital deals with the intelligence, talent, creativity, specialization and productivity of the human resources available. It indeed constitutes the basis of intellectual capital of an organization. Participation of human resources in communication

and knowledge sharing; problem detection, formulation and solution; collaboration along these lines among themselves and with customers and suppliers; and acting as part of a learning organization are all encompassed by social capital. Accumulation of experience and knowledge and their reflection to conventions, methods, and processes, and their documentation are the components of organizational capital. As revealed in the path analysis (Figure 3), it follows that human capital constitutes the basis of both social and organizational capital. One of the policies in line with the finding that intellectual capital is the most effective innovation determinant on innovativeness would be the need for emphasis on human resources. The recruitment process should be taken very seriously for attracting young innovative talent. The working environment should be conducive for innovation and growth. This is not only a must for recruitment purposes but also for the keeping the talent within the firm.

*Organizational milieu*. Formalization is at the root of the path analysis model (Figure 4). Formalization implies a well defined, documented, and properly functioning organization designed as a hierarchy of authority. Formalization supports organizational capital. It should be noted that formalization has no overlap with centralization. Management support appears as the most influential factor on innovativeness. Considering that innovation implies change we can claim that innovation management is change management. Like any change management, such as total quality management, innovation management needs top management support to overcome the hurdles encountered on the way to success. Communication and reward system are the other two factors besides management support affecting innovativeness directly. Communication construct includes components like the openness of channels between various levels of the organization; open channels among employees on the same organization level as well as with suppliers and customers, well informed employees on strategies, plans, and changes concerning the firm; existence of mechanisms for acquiring ideas and feedback from the employees in the decision making process. Open communication appears to be an effective tool for the creation of an environment conducive for innovativeness. The high correlation of management support and reward system to innovativeness emphasizes the importance of managerial encouragement to idea generation and their support to new projects for innovative capabilities. The corporate world can easily turn into a barren environment where everybody pursues their daily tasks and can't find the quality time to conceive further innovations. Usually the process of innovation also requires some time commitment and such dedication does not always result 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. A merit based transparent reward system functioning according to openly declared rules, which are approved by well-informed employees, also serves this purpose. The employees need to know that their efforts and contributions towards being innovative and thus increasing the innovativeness of the firm will be recognized and rewarded. Such awards might be of monetary type or just a simple recognition letter.

*Barriers to innovation*. Generally speaking, when the firm managers are faced with questions regarding barriers to 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 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.) particularly constitute major barriers to innovation. They do affirm that 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, managers usually consider internal resistance as among the least significant barriers to innovation. However, the SEM analysis

demonstrates that indigenous factors such as internal deficiency and internal limitations have the most significant regression values among factors that constitute barriers to innovation. Moreover, internal resistance is revealed as a factor as important as exogenous ones. 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 for less innovation. It is generally easy to point the finger to others, particularly when you are responsible for the current state of the internal environment. However, in reality the managers should find ways to overcome internal barriers in the first place.

*Collaborations*. 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 to which upper management should not turn a blind eye. In that sense, collaborations, particularly R&D collaborations, which are least utilized by the companies, are open for significant improvements in a company so that such a policy can lead to a more innovative environment.

*Firm manufacturing strategies*. Among the determinants of innovativeness, firm manufacturing strategies constitute an 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. A detailed account of business strategies, which is comprised of firm manufacturing strategy, technology development, and market focus, can be found in Ulusoy et al. [99].

To conclude we would like to emphasize the need for an innovation strategy acting as a framework for all such individual policies leading to the transformation of the firm into a more innovative and knowledge-based firm. Such a transformation cannot be achieved without the leadership of top management. Innovativeness in a firm should not be expected to occur by chance through some random events but should be cultivated through an innovation strategy with a 3-5 years rolling time horizon consisting of several time phased and possibly interacting projects. These projects should be planned, staffed, directed, and controlled with allocated budgets and sponsored by top management. Like any other management endeavour, innovation strategy together with its project portfolio should be assessed through well defined and transparent performance criteria – input and output innovation metrics [100].

As for the limitations of this cross-sectional empirical study, we can mention the fact that all the variables in our model are measured through the perceptions of single respondents representing their firms, at the same point in time. In further studies on the antecedents of innovativeness, more than one respondent from every company should be contacted. A major recent trend among manufacturing firms is to grow by the inclusion of service components such as financing, leasing, maintenance contracts, etc. [101]. This study can be extended to include manufacturing firms with service component(s) in the sample. In order to uncover the long-term nature of these relations, a longitudinal study could comprise the topic of a research proposal. A deeper study might look into how different sectors of the manufacturing industry compare in line with the model presented here. A further research topic can be the extension of this research to diverse regions and cultures. In addition, the

relations among the antecedents, including moderation and mediation hypotheses, can also be developed and tested.

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APPENDIX A: The questions of intellectual capital

| | Code | Question |
|---|---|---|
| Human Capital | e1 | Our human resources are very talented |
| | e3 | Our human resources are very intelligent and creative |
| | e5 | Our human resources are producing new ideas and knowledge |
| | e2 | Our human resources are best performers |
| | e4 | Our human resources are specialized on their jobs |
| Social Capital | e8 | Communication and knowledge sharing is high between employees from different departments |
| | e7 | Knowledge sharing and learning from each other is very common from employees from same department |
| | e6 | Regular collaboration exists for problem/opportunity detection and resolution between our employees |

| | | |
|---|---|---|
| | e9 | Frequent collaboration exists for problem/opportunity detection and resolution between our employees and customers/suppliers. |
| | e10 | Our employees may use their job expertise on specified subject on another field for problem/opportunity detection and resolution. |
| Organizational Capital | e14 | Our corporate knowledge accumulation is reflected on all corporate systems and processes. |
| | e13 | Our corporate business methods are interiorized to our employees via corporate culture means (leaders, meetings, slogans, celebrations, etc.). |
| | e12 | We are recording our knowledge accumulation on databases and manuscripts. |
| | e11 | We are taking patents, licenses etc. in order to protect all our original knowledge accumulation. |

APPENDIX B: The questions of organizational milieu

| | **Code** | **Question** |
|---|---|---|
| Management support | k22 | The development of new and innovative ideas are encouraged |
| | k20 | In my organization, developing one's own ideas is encouraged for the improvement of the corporation. |
| | k21 | Upper management is aware and very receptive to my ideas and suggestions |
| | k23 | Senior managers encourage innovators to bend rules and rigid procedures in order to keep promising ideas on track. |
| | k24 | Every employee is willing to develop new ideas and projects. |
| | k30 | It is encouraged that employees from different department come together to develop new project ideas. |
| | k28 | Individual risk takers are often recognized for their willingness to champion new projects, whether eventually successful or not. |
| | k25 | Employees can easily reach necessary information to do their job. |
| | k26 | Money is often available to get new project ideas off the ground |
| | k29 | The term risk taker is considered a positive attribute for people in my work area |
| | k27 | There are several options within the organization for individuals to get financial support to actualize their innovative projects |
| Reward system | k40 | The rewards that employees received or will receive are dependent on their work on the job. |
| | k44 | Employees with innovative and successful projects will be highly rewarded. |
| | k43 | Employees from every level will be rewarded, if they innovate |
| | k42 | Employees will be appreciated by their managers, if they perform very well. |
| | k41 | Managers increases employee's job responsibilities if they perform well |
| Centralisation | k18 | Decision making incentives are limited for middle and upper level employees |
| | k17 | Authority for making decisions on even insignificant issues rests with the senior management |
| | k19 | Routine decision making and daily tasks require approval from upper level managers |
| | k16 | Middle and lower level employees are not encouraged to take initiative |

| | | |
|---|---|---|
| | k14 | Decisions are generally made at theupper levels of the organizational hierarchy |
| | k15 | Middle level managers are not given initiative in the management ofprocesses and tasks |
| Formalization | k11 | Employees seek assistance for decision making in documents such as organization handbook, procedures and manuals |
| | k10 | Employees consider our company as a completelyinstitutionalized entity |
| | k12 | Employees are not allowed to develop their own rules while conducting their work |
| | k8 | Employees have writtenand clear job descriptions |
| | k13 | Employees are monitored constantly whether the initiatives they take violate the corporate rules and procedures |
| | k9 | Daily applications are expected to be compatible with the standard task procedures |
| Communication | k6 | Communication channels are open between upper levels of management and the employees |
| | k5 | Employees are asked for their ideas and feedbacks on major changes |
| | k4 | Employees are informed on major changes |
| | k3 | Employees are informed on corporate plans |
| | k7 | Communication channels are open among the employees at the same level of hierarchy |
| Work discretion | k38 | I always seem to have plenty of time to get everything done |
| | k39 | I have just the right amount of time and work load to do everything well. |
| | k37 | I have enough time to spend for developing new ideas. |
| Time availability | k35 | I have the freedom to implement different work methods for doing my major and routine tasks from day to day. |
| | k34 | It is basically my own responsibility to decide how my job gets done. |
| | k32 | This organization provides freedom to use my own judgment and methods |
| | k31 | I have the freedom to decide how to execute my job. |

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