INNOVATIVENESS: AN ANALYSIS BASED ON INNOVATION TAXONOMY AND DATA ENVELOPMENT ANALYSIS

by

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Abstract

Innovation is an important competitiveness determinant and is studied extensively by both the academicians and the practitioners particularly in the last decades. Dichotomous (e.g., High vs. Low) research is widely available in innovation literature in terms of analyzing the innovative capabilities and the defined determinants of innovativeness. Our approach in this thesis extends the literature by providing a conceptual taxonomy for the capabilities and determinants of innovativeness. The results demonstrate that the investigation on differences among groupings of firms yields statistical significance and actionable insights.

The main objective of this study is to model and analyse the innovative capabilities and determinants of innovativeness for a firm through conducting statistical analysis and implementing information visualization on a dataset comprising the results of an innovation survey of 184 Turkish manufacturing companies. Innovative capabilities of firms are among the leading factors defining their competitiveness, thus it is of extreme importance to define and analyze these skills and conclude with insights related to the enterprise and the industry. For this purpose, clustering analysis, statistical testing and Data Envelopment Analysis are performed and the resulting visualizations are provided. Four clusters are formed as a result of the cluster analysis, and these are labeled as the Leading innovators, Followers, Inventors and Laggers respectively. These clusters are statistically investigated under the components of intellectual capital, organizational structure, organizational culture, barriers to innovation, monitoring and collaborations. DEA analysis provide benchmarking results through efficiency scores. The end results obtained from the analyses are commented upon.

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CHAPTER 1

INTRODUCTION

1.1 Introduction, Scope and Motivation

Post-industrial organizations in todays competitive corporate world are knowledge-based organizations and their success and survival depend on the emphasis they place on creativity, innovation, discovery and inventiveness. The early examples of innovation present themselves in the shape of inventions, such as the watermill, the printing press and the wheel. Many gadgets invented throughout the existence of human kind had only one purpose to fulfill, and that was to make life easier for human beings. Today the significance of innovation to boost competitiveness and profitability is well understood in the corporate world, and the concept took on a fresh understanding that is widely perceived as the idea that generates money at the end of the day.

The concept of innovation was not present 100 years ago. In the past, manufacturing capabilities were extremely important and little significance was given to improving innovative capabilities of a firm. Today, the developing trends such as globalisation and outsourcing provide a more competitive market, and drive firms into improving their efficiency and effectiveness, rather than simply improving their product quality. Corporate world constantly seeks ways to minimize costs and maximize productivity in order to generate more revenues in an increasingly challenging fast paced business environment. Innovative capabilities also gained importance due to increased distribution networks and wide-spread internet usage. Consumers today are much more demanding for customizable products that fit their wants and needs. Hence, the market is relatively more competitive compared to the past and is becoming more and more competitive with each day. Firms try their best to exploit innovation to the fullest, simply because of the extensive emphasis placed on innovation due to the nature of the knowledge based economy. Benefits of systematic Research and Development (R&D) endeavours and constant accumulation of know-how are documented to have proven fruitful results in terms of generating additional revenues and increasing overall corporate performance and competitive capability. As a result of the emergence of Total Quality Management (TQM) around 1980s, the increased added value requirements meant increased knowledge component, thus the stress on innovative capabilities increased dramatically.

In an extended view, innovation is extremely vital for the advancement of society around the world. New and innovative products increase the standard of living and provide mankind with opportunities to improve their everyday lives. Major breakthroughs in medicine and technology have already significantly improved the living standards around the world. Moreover, innovation has also led to significant improvements in the way businesses operate and has closed the gaps between different markets.

Today, the innovation definitions by OECD (2005) are widely accepted around the world. OECD (2005) classifies innovation in four groups. These are product innovation, process innovation, market innovation and organizational innovation, respectively.

In this thesis, the concept of innovation is investigated at firm level. Hypotheses were developed and tested on 184 Turkish manufacturing firms. Six manufacturing sectors that are subject to statistical testing in this thesis include, textile, chemical, metal, machine industry, domestic appliances and automotive industries, respectively.

The goal of this thesis is to define taxonomical categories, investigate the innovativeness depending on the defined performance factors on firm level. For this purpose, cluster analysis, statistical hypothesis testing and Data Envelopment Analysis (DEA) are three methods that are resorted to for knowledge extraction.

Four clusters formed as a result of cluster analysis are labeled as Leading innovators, Followers, Inventors and Laggers respectively (Kılıc et al., 2014). Moreover, these clusters are investigated under the performance factors of intellectual capital, organizational structure, organizational culture, barriers to innovation, monitoring and collaborations.

1.2 Definitions of Innovation

One of the earlier definitions by Schumpeter (1934) describes innovation as the introduction of new goods, new methods of production, the opening of new markets, the conquest of new sources of supply and the carrying out of a new organization in any industry. On the other hand, Drucker (2002) investigates the innovation concept on a broader perspective and describes it as the effort to create purposeful, focused change in an enterprise's economic or social potential.

The innovation perception to be used in this thesis is closest to the definitions introduced by the European Commisssion reports (European Commission, 1996), explaining the characteristics of innovation in three clauses:

i. A radical or marginal extension or update on the range of products, services or markets.
ii. Development of new methods for production, acquisition and distribution.
iii. Implementation of new techniques that increase the utilization of manpower, the organization, the work conditions and the administration.

Drucker (1985) stated that innovations are extremely vital for perpetual success and are located in the heart of the entrepreneurial companies that seek further profitability and competitiveness. Continuous innovation today is essential and it has become an integral part of our lives, as we greatly benefit from direct results of innovation in the shape of products and services we use every day. The pace of innovation has been increasing over time as a requirement of todays competitive corporate world. On the other hand, innovation is occasionally unwanted since it is unpredictable, because of technological and demand uncertainties, and accurate forecasting for innovative products is almost impossible. Innovation can be disruptive. It makes competencies and knowledge obsolete and shifts bases of power and the change can be scary for some parties, both end-users and the producers. It is of vital importance to manage such an unpredictable and potentially disruptive, yet essential process in order to make the most out of it as beneficiaries.

1.3 Research Questions and Purposes

The main objective of this thesis is to develop a drivers of innovation model, and conduct a taxonomy study on an existing database of survey results from 184 Turkish manufacturing companies, observe and comment on the similarities and differences among the clusters that are categorized. A set of hypotheses testing are performed in order to explore the nature of the relationships between the cluster means of drivers of innovation. The cluster analysis and statistical testing are performed in order to comment on the explorations in the light of current innovation literature and provide examples of such instances. Furthermore, a DEA is performed as an extension to this study in order to reveal the hidden insights in the details of the data and observe insights from an even deeper perspective.

The database was compiled as part of a project funded by The Scientific and Technological Research Council of Turkey (TUBITAK) coded 105K105/SOBAG (2007). The title of the project is "Innovation Models and Implementations in Manufacturing Industry". When conducting this study, the research methodology proposed by Meredith *et al.* (1989) was taken into consideration for selection of survey application procedure. In the questionnaire designed a large number of questions are of subjective nature and a 5-point Likert scale is employed to get the assessments to these questions. By this procedure, intiutive assessments of managers or the representative staff are taken into consideration through transformation of these assessments into quantifiable scales. The subjective measurement eventually paves the way for for manager bias but is used widely in empirical research (Khazanchi et al., 2007).

The survey method is advantageous particularly because it is relatively less expensive and is easier to fill. On the other hand, it has the disadvantage of not providing the respondent needs when in doubt, thus leaving the respondent choose with his or her own perception and judgment. This study collected answers to 311 survey questions from six different industries in Turkey and 184 participating firms from several regions. A clustering analysis was conducted, related visualizations and statistical test are provided in the following chapters of this thesis.

In summary, this thesis is centered towards reaching conclusions on the conceptual and theoretical aspects of innovation in manufacturing firms in Turkey by utilizing methods of empirical analysis. The results are visualized and tabulated for facilitating understanding and comperehension, and the conclusions are expected to provide managerial insights as how to assess innovativeness among the firms from six different industries of the Turkish manufacturing firms.

1.4 Research Methodology

In this study, three main research methodologies from datamining, statistics and information visualization are used. Cluster analysis is conducted in order to obtain the groups of manufacturing firms that are significantly different from others in terms of sharing common characteristics. To test the differences of the groups in terms of the innovation drivers and the subcomponents, hypotheses are developed and put to test. Finally, a DEA analysis is utilized for the purpose of obtaining the efficiency scores of each firm and commenting on the figures with respect to clusters and industries. The principal motivation for using DEA are capabilities of the DEA for reflecting input-output relationships and for obtaining single dimensional evaluations (efficiency scores) from multi-dimensional data.

The analyses conducted in this thesis was performed in IBM SPSS v20 software. Statistical methods and hypothesis testing features in this version of the software are sufficient for performing the hypothesis tests and reaching conclusions. The DEA was performed employing SmartDEA Solver (Akcay et al., 2012). The figures in this thesis and the analytical results were visualized in yEd or Orange open-source software with versions 3.11 (yworks.com, 2014) and 2.7.6 (orange.biolab.si, 2014) respectively. The results of the analyses are gathered and conclusions are drawn in the upcoming chapters.

1.5 Organization of the Thesis

This thesis has seven chapters. Introduction and scope, definitions of innovation, research questions and purposes, and the research methodology are submitted in this chapter. The second chapter consists of the problem definition. The third chapter provides basic terminology on innovation concept and a literature review.The fouth chapter proposes a drivers of innovation model. The fifth chapter presents information on the implemented methodologies and the analyses conducted, and this chapter features basic information on the data collection procedure, the measurement of variables, fundamentals of cluster analysis and the DEA. The sixth chapter supplies the results of the cluster analysis, hypotheses testing and the DEA model, while the seventh chapter provides a summary and concludes the thesis by a summary and remarks concerning the limitations of the study. Suggestions for future work are provided as well.

CHAPTER 2

PROBLEM DEFINITION

In operations management studies, researchers utilize taxonomies in order to improve the understanding of the nature of certain concepts and explore undiscovered territories in the applicable fields to a greater extend. Taxonomies are mutually exclusive and collectively exhaustive classifications of organizations. (Nair and Boulton, 2008). The clusters formed through cluster analysis depending on single or multiple variables, are homogenous among themselves, but are seperate from the other clusters. Once the clusters are formed, one needs to label them in accordance with cluster features in order to differentiate them.

In this study, 184 Turkish manufacturing firms are subjected to a cluster analysis. Four firms are left out by the software as they did not fit into any of the clusters and the remaining 180 firms are clustered in 4 distinct groups and labeled according to their level of innovativeness in compliance with OECD's (2005) definitions of innovation types.

The investigation of differences among the cluster groups obtained were done statistically by hypothesis development and testing. For further analysis, a DEA was conducted and the results were inspected and interpreted visually. The methodology for the Cluster Analysis, the Hypothesis testing and the DEA and the results are provided later in this thesis in Chapters 5 and 6 respectively.

CHAPTER 3

BASIC TERMINOLOGY AND LITERATURE REVIEW

3.1 Importance of Innovation and Basic Terminology

Innovation has gained significance in all industries particularly in the last decade where technological advancements have paved the way for increased emphasis on creating means of production resulting at lower costs and satisfying customer demand.

Today companies need innovation for various reasons. Innovation brings about economic growth by transforming the old products, services or processes into new by using the new technology and knowledge. It is necessary for overall human wealth and well-being, as more innovation means more businesses, and more businesses require more labor force and this leads to an increase in employement. Innovation creates new jobs for people and provide the income for families of all levels. Innovation accelerates the improvement process on new products, and change our way of living. As a direct consequence of the benefits provided by innovation, today human beings are enjoying a greater level of comfort and live on higher standards. Human basic needs and wants are more than satisfied by the new products that are introduced each year. Innovation provides competitive advantage to firms by capturing value in the existing markets or the newly generated markets. Innovation aids profitability of a firm by cutting down on costs and thus enabling to survive and thrive in the markets. While minimizing the costs, innovative activities also aim to maximize the revenues. In order to do so, marketing and product innovations play a significant role to increase customer awareness and offer better products to the markets. Innovation takes advantage of the opportunity by capturing the idea that will sell and generate money out of the realization of the idea. The return on investment on innovation can be relatively high, when the idea is right and timely. It is crucial for firms not to ignore the importance of innovation and rather continue to invest on a constant stream of innovative activities, if they want to survive and thrive in todays' extremely competitive market.

3.2 Innovation Types and Innovation at Firm Level

One of the first categorizations of innovation concept was introduced by Schumpeter in 1934. Schumpeter (1934) defined the five types of innovation as new products, new methods of production, new sources of supply, the exploitation of new markets and new ways to organize business.

A more recent classification of innovation is provided by OECD (2005) in the Oslo Manual document and is accepted world-wide as the international standards for defining innovation and data collection and measurement of innovation. According to the OECD definition, there are four types of innovation. These are product innovation, process innovation, marketing innovation and organizational innovation.

Henderson and Clark (1990) categorize innovation types in terms of their impact on component knowledge and the architectural knowledge. Products with low architectural knowledge and low impact on component knowledge are incremental innovations, while those with low impact on architectural knowledge and high impact on component knowledge are modular innovations. Products with high architectural knowledge and low impact on component knowledge are architectural innovations, while those with high impact on architectural knowledge and high impact on component knowledge are termed radical innovations.

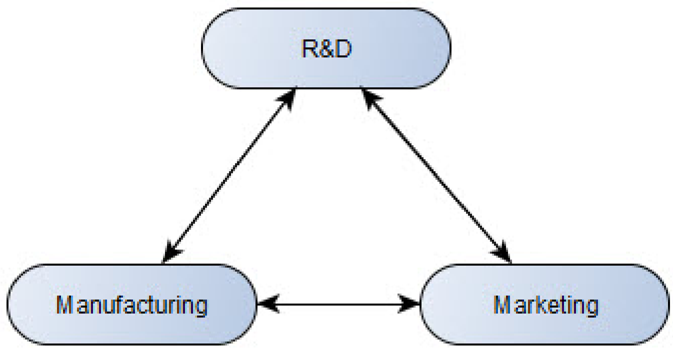


Figure 3.1. In-firm relations in the innovation process

Innovativeness is translated to competitiveness and profitability for the firm in the corporate world. The recent trend in the industry is to define innovative endeavours as ideas that will result in revenues at the end of the day. Regardless of the industry, in any given firm, conducting successful innovative processes requires a strong relation between three departments, namely, R&D, marketing and manufacturing departments. This relationship takes the form of a triangle and is depicted in **Figure 3.1**. These three entities reinforce each other in the sense that when an innovation is generated in any one of the entities, it boosts the effectiveness of the others. In order to accomplish innovatively successful projects, these three entities must collaborate and a strong flow of information between the departments must be established.

3.3 Review of Innovation Literature

3.3.1 Drivers of Innovation

The model developed in this thesis contains six drivers of innovation. These are intellectual capital, organizational structure, organizational culture, barriers to innovation, monitoring and collaborations respectively. The drivers of innovativeness are defined and proposed as the structure within the framework of the model developed in this study.

Related recent literature for each driver can be found in the following sections. Each subsection from 3.4.2 to 3.4.8 provide the recent literature shedding light on the drivers of innovativeness either in the case of empirical or theoretical studies.

3.3.2 Intellectual Capital

Vargas-Hernandez and Noruzi (2010) review the Intellectual Capital concepts in management perspective, and suggest ways in which intellectual capital and learning organization can be utilized and enhanced in order to improve the organizational competitiveness of a firm.

Hsu and Sabherwal (2012) investigate the relationship between intellectual capital and knowledge management on empirical data. Their study consists of a dataset derived from 533 Firms in Taiwan. The authors report that the intellectual capital effects knowledge management and dynamic capabilities, knowledge management facilitates innovation but not dynamic capabilities or Intellectual capital, firm performance depends on the efficiency and innovation but not directly on the dynamic capabilities, and efficiency does not depend on any of the other constructs proposed in the study.

Wang and Chen (2013) analyze the nature of high-performance work systems and how they facilitate the incremental and radical innovative capabilities. The authors investigate the mediating role of intellectual capital on these two entities. Their data consists of 164 Chinese firms. Their findings report that Organizational and social capital mediate the relationship between HPWSs and incremental innovative capability, whereas social capital mediates the relationship between HPWSs and radical innovative capability.

Bellora and Guenther (2013) identify innovation capital disclosure characteristics in the intellectual capital statements. The authors investigate the relationships of these statements with industry, firm size, region etc. 51 European Firms are studied in this paper and homogenous disclosure patterns across the regions in Europe are reported.

Longo and Mura (2011) investigate the effect of intellectual capital on employees' satisfaction and retention and identify two Human Resources practices which positively influence intellectual capital. Structural Equation Modeling (SEM)was used in their study and their database consisted of 1117 employees from a large italian company in food industry.

The authors report that human and relational capital do not directly affect employees' job satisfaction, and they are affected by structural capital.

Luno et al. (2011) investigate the effects of interorganizational links on radical innovation using a comprehensive framework and integrate social capital, knowledge based view and innovation. The analysis on 143 firms of innovative manufacturing and service industries yield the information that knowledge complexity has a clear influence on radical innovation, and the mere existence of strong cooperation agreements do not guarantee radical innovation.

Ruta (2009) elaborates on how the Human Resource portal configuration is facilitating intellectual capital creation and development. The author works on a case study of a major consulting firm and finds out that HR configurations for consulting firms are designed for social capital creation and development.

Subramanian (2012) performs a longitudinal study in order to explore the relationship between intellectual human capital and exploratory innovation within organizations. The author conducts the study based on the data obtained from patent, publication and financial information from biotechnology firms.

Mura et al. (2012) introduce and empircally test a theoretical model that links intellectual capital dimensions to employees innovative work behaviour and suggests knowledge sharing behaviour among employees as a key mediator. The data consists of 135 employees in 3 healthcare organizations and SEM is used.

Adrian (2008) explains the intellectual capital notion, the definitions, and its components, and remarks that information is static whereas knowledge is dynamic.

Marcin (2013) takes the intellectual capital in a regional perspective. He ennumerates knowledge indicators for measuring intellectual capital at national level, and uses Knowledge Assesment Methodology (KAM).

Mention (2012) systematically reviews the intellectual capital literature and comments on the complex relationship between intellectual capital, innovation and performance.

Zerenler et al. (2008) investigate the Influence of intellectual capital of Turkish automotive supplier industry upon their innovation performance. The study shows that three types of intellectual capital –employee capital, structural capital, and customer capital– have a significantly positive relationship with innovation performance. Moreover, the results also indicate that the higher the growth rate of an industry, the stronger are the positive relationships between three types of intellectual capital and innovation performance. Besides, customer capital is the greatest among these three types of intellectual capital in Turkish automotive supplier industry, employee capital is the next, and structural capital is the last. This shows two points; first, Turkish automotive supplier industry emphasize the interactive "relations" with their suppliers, clients, and partners; second, it is imperative for Turkish manufacturing enterprises to develop their structural capital to increase their innovation performance.

Ding and Li (2010) perform a study on the Management of Intellectual Capital and how it gradually replaces the real capital and changes to the headspring of value enhancement for modern enterprises. The authors remark that to acquire advantages in the market competition, modern enterprises should not only innovate upon products, marketing channels and services, but also increase the emphasis placed on the R&D and the firm's ability to market their products. Moreover, They should also pay attention to the cultivation of in-house knowledge and the proliferation of the Intellectual Capital.

Kong and Thompson (2009) provide a new intellectual capital perspective of human resource strategies and practices by providing an overview of connections between three elements: Intellectual Capital, Human Resource Management and Strategic Human Resource Management

Wu and Sivalogathasan (2013) refine the existing intellectual capital literature methods with respect to unique characteristics of the industries. The authors examine the relationship between intellectual capital and organizational motivation and further elaborate on multidimensional and contingent gradual effect of intellectual capital on innovation capability.

Guo et al. (2012) study on intellectual capital and firm performance in 279 biotech companies in the United States from 1994 to 2005, and claim that R&D expenditure increases the number of patents, increase in patents do not increase accounting performance, and finally the quality of human capital plays a positive role in technology innovations and financial performance.

Curado and Henriques (2011) propose an integrated framework for intellectual capital disclosure. The authors report that the measure, manage and report intellectual capital process enables firms to more accurately describe their intangible assets.

Molodchik et al. (2012) conduct a literature research. The authors propose a detailed algorithm for intellectual capital evaluation in terms of input-outcome transformation. Intellectual Capital Transformation Evaluating Model (ICTEM) was utilized in this study.

Abeysekera (2007) compare Intellectual capital reporting (ICR) of large firms in Sri Lanka with Australia. The author uses a dataset consisting of the top 30 firms in market capitalization listed on the Colombo stock exchange, and reports that the ICR differences identified between two countries can be attributed to economic, social and political factors. The novelty of this study is that it provides insights into comparative reporting practices between a developed and a developing country.

Kujansivu and Lönnqvist (2007) investigate the value and efficiency of intellectual capital and comment on the present state of intellectual capital in Finnish companies. The authors explain the relationship between concepts value of intellectual capital and efficiency of intellectual capital. The data used in this study is collected from 20.000 companies in 2001-2003, and correlation analysis is used in order to analyze the proposed model. The authors comment on the value and efficiency of IC that are described in 11 industries in both SMEs and large companies. The originality of this study is that it provides an analysis of relationship between measures of CIV and VAIC that has not been conducted before.

Echebarria and Barrutia (2013) investigate the social capital as a limitation and conduct an empirical analysis in the context of European regions. The authors conclude that there exists an inverted U-shape relationship among some components of social capital and innovation.

Link and Ruhm (2011) differentiate between public and private knowledge and comment on the intellectual capital of entrepreneurs. The authors investigate the innovative actions of entrepreneurs, their tendency to reveal the intellectual capital that results from their research effeorts in terms of publications or patents. The dataset comes from National Research council within the US national academies, small business innovation research awards between 1992 and 2001. The findings of this study are several. The authors report that entrepreneurs with academic background are more likely to publish their intellectual capital.

Business bakgrounded entrepreneurs are likely to patent their IC. Universities aid the academic entrepreneur but not the business entrepreneur.

Wu et al. (2008) aim to discover how a firm's operational mode reinforces the advantages of intellectual capital on innovation. They develop a comprehensive research model to integrate the relationships among social capital, entrepreneurial orientation, intellectual capital and innovation. They also note on the moderating effects of spcial capital and entrepreneurial orientation on innovation. The finding of this paper is that firms with higher levels of social capital and entrepreneurial orientation tend to amplify the effects of intellectual capital on innovation.

Castro et al. (2013) analyse the internal complexity that characterises technological innovation in firms. They document that the innovation capability of a firm depends closely on its intellectual and/or organisational knowledge assets and on its ability to deploy these assets. The dataset consists of 251 Spanish high and medium-high technological manufacturing firms, and multiple regression models were developed in order to analyze the data. The findings reveal the existence of the moderating role of innovation culture in a knowledge-based product innovation model.

Lopez-Cabrales et al. (2010) aim to discover the relation of organizational learning capability with human resource management practises, assess the extension of the value and uniqueness of human capital that is associated with OLC and the possible mediating role of human capital in the relationships between HRM practises and OLC. The sample dataset consists of companies in the most innovative sectors of spanish indusrtry, and the analysis applies the Partial least squares technique. The authors document that there is a direct relationship between human capital and the value and uniqueness of employees' knowledge and this human capital is associated to HRM practices.

Carmona-Lavado et al. (2013) investigate the influence of human, social and organizational capital and intensity in collaboration with clients on service innovativeness in knowledge-intensive business services. The dataset is a sample of companies belonging to two technology-based KIBS industries: software and R&D Services The findings are that the positive effect of human capital on service innovativeness is moderated by intenstiy in collaboration with clients, the effect of social capital on service innovativeness is partially mediated by human capital and also moderated by intensity in collaboration with clients, and the service innovativeness positively affects innovation success, while intensity in collaboration with clients has a higher effect.

Carmona-Lavado et al. (2010) study the influence of organizational and social capital on firms' product innovation, and the moderating role of radicalness and report that the social capital favors firms' product innovation, especially under radical innovations, the organizational capital has an indirect effect on product innovation through positive influence on social capital, and firms can stimulate communication and interaction among people, and therefore innovative activity, by means of explicit and codified knowledge.

Farsi et al. (2013) investigate the impact of social capital on organizational innovation by studying the mediating factor of entrepreneurial orientation in auto parts manufacturers. The authors conduct their analysis using the partial least squares structural equation modeling (PLS-SEM) method on a dataset collected from Iranian auto parts companies. The findings illustrate that the social capital has a positive, significant impact on organizational innovation and entrepreneurial orientation among the staff. Entrepreneurial orientation of the staff in turn affects organizational innovation, which confirms the mediating effect of entrepreneurial orientation on the relationship between social capital and organizational innovation.

Musteen and Ahsan (2011) use the intellectual capital perspective as a theoretical framework, and develop a conceptual model of offshoring of knowledge-intensive, complex work by young, entrepreneurial firms. They posit that the unique qualities of human, social, and organizational capital of such firms drive them to offshore complex, nonroutine activities to foreign vendors. Furthermore, the authors claim that offshoring of such activities might lead to innovation under certain intellectual capital configurations.

Chang and Chen (2012) integrate the theories on corporate social responsibility and green management to develop an integral conceptual model of green intellectual capital to explore its managerial implications and determinants. The authors use SEM on Taiwanese firms' dataset.

3.3.3 Organizational Structure

Nagappan et al. (2008) investigate the influence of organizational structure on the software quality by conducting an empirical case study.The findings of the study conclude that the organizational metrics are related to, and are effective predictors of failure-proneness.

Zheng et al. (2010) aim to establish a link between organizational culture, structure, strategy and organizational effectiveness by studying the mediating role of knowledge management. A dataset consisting of survey responses from 301 organizations are analyzed and the results suggest that the knowledge management mediates the impact of organizational culture and organizational structure and strategy on organizational effectiveness.

Hornsby et al. (1993) review the intrapreneurship and entrepreneurship literature for consistent organizational and individual characteristics paving the way for innovative behaviour. Authors propose a framework model in order to explain the intrapreneural process of firms based on past theoretical and empirical research.

Sundbo (1999) investigates how well firms are succesful in development of entrepreneurship competencies and the conditions leading to success in the area. The author analyzes a small Danish bank in a framework consisting of innovation theory, organizational theory and the human resource management theory. The findings demonstrate that it is possible to develop an innovative learning structure within the firm positioned around corporate entrepreneurship. The condition for entrepreneural success for the firm is reported to be that the extended barter between the firm and the employees is satisfactory on both sides.

Van den Ende et al. (2003) investigate the coevolutionary process of firms to organize their innovative endeavours and the dynamics of the markets. The authors focus on the extent of the internal autonomy, the integration of R&D, production activities in the product development process and the external autonomy. Taking into account three cases, the authors develop hypotheses on the relation between the organization of innovation and bandwagon and network effects.

Koberg et al. (1996) investigate the macro level facilitators and inhibitors of innovation, which are considered to be organizational and environmental conditions of a firm that promote or restrain innovation in the firm. Organizational structure, the incentive system, the resources provided to the employees are considered in the study. The results of this study, using data from 326 U.S. firms in different stages of their development and are involved with various kinds of high-tech industries, support the proposed theory that there is a relationship between a facilitator and innovation changes as the firm evolve. The authors report that formally structured young firms are less innovative than informal ones and formalization had no negative impact on innovation in relatively older firms.

3.3.4 Organizational Culture

Barney (1986) investigates the organizational culture and the degrees to which it can be a source of sustained competitive advantage. The author claims that the firms without the required cultures are not capable of of engaging in activities to modify their cultures and generating sustained financial performance. Firms with the required cultures can obtain sustainable development and superior financial performance.

O'Reilly et al. (1991) discuss the assessment of person-organizational fit by bringing together a renewed interest in assessing person-situation interactional constructs, the quantiative assessment of organizational culture, and the application of template matching approaches. The authors investigate a dataset consisting of longitudinal data from accountants and MBA students, as well as a cross-section from the industry. They report that organizational culture is widely open for interpretation as a direct result of the dimensionality of individual preferences for organizational cultures.

Hornsby et al. (2002) aim to assess the measurement of properties of a scale to measure the essential factors which effect the middle managers to increase innovative activities in a firm. In their study, the authors cover critical factors such as the appropriate use of rewards, gaining top management support, the resource availability, supportive organizational structure and risk taking and tolerance for failure. The authors developed a Corporate Entrepreneurship Assessment Instrument (CEAI) as an assessment tool. The assessment tool consisted of 84 Likert-scale questions. The results demonstrate that the five organizational culture factors are present in the studied firms and from a managerial perspective, CEAI can be a useful tool in diagnosing a firm's environment for corporate entrepreneurship and development of effective training programs for middle managers.

Schein (1984) defines the concept of organizational culture in terms of a dynamic model on how culture is learned, passed on and changed. The author proposes a framework on the emergence of organizational culture in a firm, how it is inherited by the future employees and how it can evolve.

Kuratko et al. (1990) investigate methods to measure the effectiveness of an environment or culture for the implementation of innovative ideas. The study attempts to define the factor structure by proposing a framework for measurement of intrapreneurship culture through the development of the intrapreneurship assessment instrument (IAI). The authors utilize the assessment tool to assess the effectiveness of an intrapreneurship training program in a Fortune 500 company.

Alpkan et al. (2010) investigate the impacts of the internal supportive environment for intrapreneurial activities on firms innovative performance and the degree to which human capital plays a moderating role in this relationship. The authors conducted a survey questionnaire to 184 Turkish manufacturing firms and the results demonstrate that the management sıpport for idea development and risk tolerance are positively effecting the innovative performance in the firms. The findings also support that the availability of a reward system and allocation of free time have no impact on innovativeness, whereas work discretion has a negative effect.

Alpkan et al. (2007) examine the joint effects of market orientation and planning flexibility on business performance. The authors develop and test hypotheses concerning the nature of relationship between the factors on a dataset consisting of small and medium-sized Turkish manufacturing firms. The findings in this study demonstrate that both market orientation and market flexibility have a positive influence on firm performance.

Naranjo-Valencia et al. (2011) investigate the effect of organizational culture in terms of fostering or inhibiting the overall organizational innovation as well as the immitation strategy. The study utilizes a dataset consisting of 471 Spanish firms to develop and test hypotheses. The findings display that organizational culture is a clear determinant of innovation strategy and adhocracy cultures foster innovation strategies and hierarchical cultures promote imitation cultures.

Martins and Terblanche (2003) propose a model that presents the determinants of organizational culture that boost creativity and innovation. The authors identify the determinants as strategy, structure, support mechanisms, behaviour to encourage innovation and open communication. The authors further discuss the effect of each determinant on creativity and innovation.

Morrison and Robinson (1997) examine the organizational culture concept in a psychological perspective. The authors propose a model explaining the sensemaking process preceding and employee's experience of psychological betrayal, and identify the factors which affect the psychological processes with the purpose of influencing future empirical research.

Khazanchi et al. (2007) aim to explore how organizational culture values impact a particular process innovation, the implementation of advanced manufacturing technology (AMT). The authors examine the value profiles, value congruence and value-practice interactions.

Claver et al. (1998) analyze the origins of organizational culture emergence in firms that presents itself in innovation technology. The authors investigate the most important conditions for the generation of a corporate culture based on technological innovation.

3.3.5 Barriers to Innovation

Shorr (2010) explains why the companies resist to innovation and summarizes the internal factors in his own words. The top ten apparent reasons are the fear of failure, the fear of success, the fear of looking foolish, the fear of being first, the inertia, complacency, unwillingness to act on intuition, stereotyping, not enough energy to sell the ideas internally, and the companies being too busy with other means of work that will produce added-value.

Chesbrough (2010) studies on the exploration of barriers to business model innovation including conflict with existing assets as well as cognition. The author cites and provides an extended research on the previous academic works on the barriers to innovation. Chesbrough (2010) further elaborates on the barriers and converys the learnings through a case study on Xerox and the Compact Disc piracy.

D’este et al. (2011) argue that there are two types of barriers to innovation, and these are revealed barriers (degree of difficulty of the innovation process and the learning experience from the firms engagement in innovation activity) and deterring barriers (obstacles that prevent the firm from committing to innovation) respectively. The dataset is obtained from the 4th UK Community Innovation Survey. The findings illustrate that there exists a strong relationship between the types and it is curvilinear in case of costs and market barriers.

Zhu et al. (2011) invesitage how institution based barriers affect innovation in SMEs in China. The authors develop a Cost-Risk-Opportunity (CRO) model for innovation. This study focuses on the data obtained from interviews conducted to 82 managers and owners at 41 SMEs in China. The findings yield that the five key institution-based barriers to innovation in China are Competition fairness, Access to financing, laws and regulations, tax burden and support systems respectively.

Madrid-Guijarro et al. (2009) resarch on barriers of manufacturing SMEs in Spanish context. The authors examine the relation between product, process and management innovation, as well as thge 15 obstacles and their significance as barriers. The analyses conducted in this study involve simple regression modelling and hypothesis testing on 294 Spanish SMEs. The findings illustrate the facts that most significant barriers are associated with costs, least significant barriers are associated with manager/employee resistance, and the costs associated with innovation have greater impact on small, rather than large firms.

Fortuin and Omta (2009) compare barriers to innovation in business/industry to food processing industry to come up with actionable insights and propose improvements in food processing industry. The dataset used in this study involves 9 multinational food processing firms in Netherlands The authors conclude that the open innovation is underutilized in food processing industry, and the high pressure from the buyers acts as a strong driver for innovation. The originality of this paper is that it is the first to investigate innovation concepts in the context of food industry.

Foxon and Pearson (2008) investigate the policy making for transition to sustainability. The authors propose guiding principles for sustainable innovation policy processes, and these are, stimulating the development of a sustainable innovation policy regime, bringing together innovation and environmental policy regimes, and applying systems thinking, engaging with the complexity and systemic interactions of innovation systems and policy-making processes, to promote a transition to sustainability. The study presents a case study on low carbon emission in the UK and the transition approach implemented in the Netherlands.

Metze and Levelt (2012) explain how collaborative regional governance and credibility of innovation are imposed by municipalities. The authors emphasize the barriers to innovation in regional coordination of government unit and the study overviews 4 Dutch city-regions.

Demirbas et al. (2011) investigate on the effect of perceptions as barriers to innovation and conduct analysis on empirical evidence from 224 Turkish SMEs. This study introduces certain characteristics of SME's in Turkey compared to USA, Japan, UK and South Korea and comment on the general featuristics of SME entrepreneurs in Turkey. The authors develop a logit regression model and hypothesis test four proposed ideas. The findings illustrate that the lack of robust government R&D policy poses as a formal barrier, and the lack of sizeable and thriving economy as an informal barrier that drives the investment away, thus making it costly for SMEs to innovate. They also conclude that the innovation decisions of the owners are highly affected by the lack of appropriate sources of finance and skill shortages.

Gülcan et al. (2011) compare two Turkish cities, Istanbul and Denizli, in Textile industry in terms of knowledge generation capabilities and comment on the strengths and weaknesses of their Regional Innovation System. The authors collected answers to 27 questions from 54 firms in two cities, and their analysis concludes that the relatively smaller city has the advantage of containing less companies but more interaction among them that will boost innovation, while the relatively greater city has more companies but these companies do not interact among each other sufficiently in order to generate knowledge and increase innovation.

3.3.6 Monitoring

Bernhardt (1994) describes what competitive intelligence is, why it represents a key element in the strategic management system of the company, and how it works in reality. The author suggests definitions and key concepts into a deeper understanding of the notion of competitive intelligence.

Prescott (1999) provides a historical overview of the evolution of competitive intelligence (CI), and the related concepts including the intelligence production process. The author further evaluates on a framework containing four levels of sophistication in CI programs. The author remarks that CI can aid in creating more competitive responses to requests for proposals and commercial opportunities.

Calof and Wright (2008) trace the origins of Competitive Intelligence fields and identify the practitioners, academics and inter-disciplinary views on CI practice. The authors review the CI literature extensively. The authors report that their analysis supports the view of competitive intelligence being an activity consisting of environmental scanning and strategic management literature.

Qiu (2007) investigate how entrepreneurial attitude and normative beliefs influence managerial scanning for competitive intelligence and how managerial scanning efforts affect managerial interpretation of organizations' strengths and weaknesses in the competitive arena. The author conducts the analysis on a dataset consisting of survey results from 309 managers in the USA. The findings demonstrate that entrepreneurial attitude orientation and market orientation significantly impact managerial scanning for competitive intelligence.

Jaworski et al. (2004) investigate how competitive intelligence is generated within an organization. The authors propose a conceptual framework describing three stages of CI generation process: organizing for CI, searching for information and sensemaking. The proposed framework can be utilized for managing the CI generation process and is discussed further in the study.

Bose (2007) studies and reports the process used to create and maintain a CI program in organizations and provides an analysis of several emergent text mining, web mining and visualization-based CI tools that are specific to collection and analysis of intelligence. The findings of this study constitute a guideline aiding the decision makers and strategic managers make better understanding of the methods and tools available for making accurate decisions in the steps involved in generation of CI.

Wright et al. (2002) conduct a pilot research project on UK firms for a better understanding of their approach to competitive intelligence. The authors develop a tentative typology of companies reflecting the attributes attitude, gathering, use and location.

Teo and Choo (2001) study the impact of wide spread internet usage by firms for the purpose of generating CI. The authors use the results of a survey questionnaire for their analysis and the results demonstrate that research and external use of the internet is significantly related to the quality of CI information. Moreover, the relationship between internal use and quality of CI is not detected to be significant. Furthermore, the study reveals the empirical evidence suggesting that the quality of CI information is positively related to organizational impact and further implications are discussed.

Rouach and Santi (2001) investigate the growing importance of CI as a management practice in the majority of leading companies. The authors review the CI literature in order to define the factors the CI is composed of, and further elaborate on the nature of CI as an innovation performance booster.

3.4.7 Collaborations

Waite and Williams (2009) examine the social capital's influence on development of horizontal export-focused industry clusters. Evaluating the dataset from 9 SMEs in Australia, the authors report that the collaboration among SMEs increase their effectiveness in international markets.

Felzenstein et al. (2010) focus on a dataset incorporating the salmon industries from Scotland and Chile and further explain the marketing collaboration among cluster-based firms and the nature of the relation between geographical distance and inter-firm marketing cooperation.

Beers et al. (2008) investigate the determinants of innovating firms' (foreign & domestic) R&D Collaboration with domestic universities and public knowledge institutes in Finland and the Netherlands. The authors base their research on Community Innovation Surveys (CIS) in Finland and Netherlands for the duration 1996-2000. The results illustrate that the foreign firms in Netherlands are less likely to cooperate with domestic public knowledge institutions than domestic firms, while in Finland there is no statistical significance.

Spence et al. (2008) investigate the use of collaboration in Canadian SMEs and aim to explain the determinants in measuring the success of international ventures.

Arto and Monroy (2009) probe to examine why and how Global Manufacturing Virtual Networks emerge, and their nature. The authors provide a global framework for information and communication technologies in Global Manufacturing Virtual Networks.

Monroy and Arto (2010) articulate on the causes behind the establishment of Global Manufacturing Virtual Networks and analyse these networks. The authors investigate their convergence to new trend of mass customization and provide a case study on Rolls Royce.

Lööf (2009) aims to estimate the knowledge spillovers to multinational enterprises in Sweden via domestic and foreign R&D collaboration. The data is collected from 1249 enterprises. Augmented generalized method of moments-estimator that accounts for selectivity and simultaneity bias are used. The findings of this study demonstrate that the knowledge spillovers via R&D collaboration is a network phenomenon rather than a process, successfull collaboration requires foreign innovation partners, output is an increasing function of R&D collaboration only among non-export oriented firms, and the foreign multinational enterprises benefit more from R&D collaboration.

Bogers (2011) analyzes ways to protect the R&D know-how and how much information to share. The author provides extensive literature review and interviews, and develops a framework based on the case studies. The results suggest revealing methods on how to cope with the problem and the dataset is collected from 8 Danish firms actively involved in collaboration. The novelty of this paper is that it provides a holistic perspective on the knowledge paradox in R&D collaborations as a coupled process of open innovation. It also provides two strategies to cope with the "tension field" as well as the role and implications of licensing as a particular mechanism to overcome the open innovation paradox:

Open knowledge exchange strategies, layered collaboration schemes with inner and outer members and licensing.

Buganza and Verganti (2009) investigate the organizational aspects of an open innovation approach by focusing on the relationship between universities and firms as a tool for acquiring technological knowledge. The dataset exploited in this study comes from an Interview-based case study method with 4 companies (from telecom, construction and aviation industries). The results illustrate that the companies take into account the technology lifecycle (S-curve) and its associated phases while acquiring knowledge from universities, and these four main variables determine the decisions by firms on the relationships with the universities: number of people involved in the organizational unit, positioning of the organizational unit within or outside the firm, degree of work specialization in the organizational unit, and the degree of formalization of the process. The novelty of the paper is that it is the first attempt to analyze the open innovation concept from an organizational perspective.

Soosay et al. (2008) investigate how collaboration helps continuous innovation in the supply chain through a dataset from interviews with 23 managers in 10 case studies. The authors conclude that the differing relationships impact on the operation of firms and their capacities to innovate. Working together aids integration, increases effectiveness and offers radical and incremental innovation.

Hawkins and Little (2011) investigate the catalysts required to develop, promote, implement and maintain effective collaborative practice with special significance attached to the benefits of business collaboration and partnering with world's first national standard BS 11000. The authors comment that the BS11000 standard provides a solid bases on which firms can build more sustainable relationships.

Hingley et al. (2011) examine how using fourth-party logistics management might improve horizontal collaboration among grocery retailers through a data obtained from 3 suppliers, 3 logistics firms and 1 grocery store retailer. The findings reveal that the fourth-party logistics negatively influence the retailer-supplier dynamic but provides potential benefits, and the novelty of this study is that it constitutes an example from a high volume, mass market industry that needs enormous logistics infrastructure and highly embedded networks of relationships.

Gellynck and Kühne (2010) study the innovation concept in networks and its application to the traditional food sector. The authors comment on the collaborative characteristics of the industry, and also mention the barriers that prevent collaboration in this sector, which are lack of trust, lack of knowledge on benefits of networking, lack of financial and physical resources and lack of knowledge on appropriate methods and skills. The dataset consists of interviews in Belgium, Hungary and Italy with 84 participants on 6 food types.

Parida et al. (2012) investigate SME adoption of open innovation by conducting hypothesis testing on 252 high-tech SMEs from Sweden. The authors' findings demonstrate that different open innovation activities are beneficial for different innovation outcomes.

Santamaria and Surroca (2011) analyze the fitness/match of a firm choosing a technological partner and its impact on the business. The authors conduct their analysis on a dataset collected from 1300 Spanish manufacturing firms over 5 years in a longitudinal study, and the findings demonstrate that forming alliances with vertical partners to exploit existing competences leads to likelihood of obtaining product and process innovations. Horizontal collaboration is for pre-competitive search and does not have much effect on innovation outcomes.

Reniers et al. (2010) identify collaboration drivers and partner features for enhancing the vertical and/or horizontal collaboration in chemical using industries. The authors propose a framework for Advancing and Stimulating Collaboration (ASC) in chemical industry.

Nieto and Santamaria (2010) describe how technological collaboration helps as forming the input to innovation process and how SMEs can use it to bridge the innovation gap between them and the large firms. The authors conduct a longitudinal study on Spanish manufacturing firms and the results illustrate that technological innovation is beneficial for all, but the benefit depends on the innovation output and type of partner. The significance is much higher for product than process innovation for SMEs. Regarding type of partner, vertical collaboration—with suppliers and clients—has the greatest impact on firm innovativeness, though this effect is clearer for medium-sized enterprises than for the small firms.

Owen et al. (2008) examine how collaborative innovation emerges in extended enterprises and provide a guideline for managing and administrating collaborative behaviour.

The authors generate a collaborative innovation ABC, that is Alignment, Boundaries and Commitment.

Bahinipati et al. (2009) examine how horizontal cooperation in semiconductor manufacturing industry supply chains may emerge, by proposing quantiative models to assess the degree of collaboration and generating AHP-fuzzy models.

Giesen et al. (2007) identify three types of business model innovations: industry models, revenue models and enterprise models. The authors compare the three types in 35 Best practice cases and the study is based on IBM Dataset. The authors remark that the products and services can be copied, but the business model is the differentiator.

Lhuillery and Pfister (2009) investigate the R&D cooperation and failures in innovation projects by studying on data from French Community Innovation Survey. The authors report that 14% of R&D collaborating firms in France had to abort projects due to partnership difficulties (cooperation failures), and the firms collaborating with competitors and public research organizations are more likely to stop or abort an innovation project. Larger firms face less risk for cooperation failures.

Ili et al. (2010) study the concept of open innovation in the automotive industry. They report that the open innovation proves to be more adequate in the attempt to achieve a better R&D productivity for companies in the automotive industry than a closed innovation model.

Tomlinson (2010) explores the impact of cooperative ties upon levels of innovation (product and process) in 5 industries and 436 manufacturing firms. The originality of this paper is that the hypothesis developed that posits vertical cooperative ties are significant in explaining the firms level of innovative performance finds statistical significance.

Tsai (2009) evaluates the absorptive capacity’s effect on the relationship between partners and product innovation performance. The analysis conducted in the study involves a moderated hierarchical regression approach on 753 firms from Taiwanese Technological Innovation Survey.

Czarnitzki et al. (2007) investigate the relationship between R&D Collaboration, Subsidies and R&D performance. The authors remark that in Germany, subsidies for individual research do neither exhibit a significant impact on R&D nor on patenting, but the innovative performance could be improved by additional incentives for collaboration. For

Finnish companies, public funding is an important source of finance for R&D. Without subsidies, recipients would show less R&D and patenting activity, while those firms not receiving subsidies would perform significantly better if they were publicly funded.

Moodysson and Jonsson (2007) examine the role of functional and relational proximity for knowledge collaboration among biotech firms. The authors' findings demonstrate that the embodied knowledge is more sensitive to functional proximity than projects with encoded knowledge, the local knowledge is never enough, firms seek global knowledge, thus, form collaborations, and the policy resources aimed at promoting bioregions are better used for enhancing local resources and providing biotech firms to link up with global resources.

Segarra-Blasco and Arauzo-Carod (2008) identify the determinants of R&D cooperation agreements among firms, customer and suppliers, competitors, universities and public research centers. The authors focus on innovative firms and universities, and the dataset comes from 4150 firms that participated in Spanish Community Innovation Survey.

MacCormack et al. (2007) comment that the idea of centralized and isolated R&D teams is obsolete and explain the strategies and practises used by firms to achieve greater success through collaborative innovation efforts. The authors cite the common mistakes by companies that do not lead to success through collaboration as the following: focusing on lower costs while failing to consider the broader strategic role of collaboration; not organizing effectively for collaboration; believing that innovation could be managed much like production and partners treated like "suppliers."; not investing in building collaborative capabilities; assuming that their existing employees and processes are already equipped for the challenge.

Leiponen and Byma (2009) examine how the SMEs can get greater return on their R&D investment and how they perceive innovation. The authors comment that most small firms take pride in returns by speed to market, and those working closely with universities believe that the number of patents is the major indicator.

Drejer and Vinding (2007) explore the relation between absorptive capacity and the propensity to collaborate across geographical distance. The authors report that the firms located in the relatively sparsely populated region are more likely to collaborate with firms located outside the region; and for these firms, the level of absorptive capacity matters for the distance to the collaboration partners—firms with a low level of absorptive capacity tend to collaborate with domestic partners, while those with a high level of absorptive capacity are much more likely to find their main product-innovation partner abroad. Their dataset is composed of 2 Danish neighbouring regions.

Abramovsky et al. (2009) discuss the roles of knowledge flows, cost and risk-sharing and public financial support in firms' decisions to collaborate. The authors analyze the dataset composed of firms from France, Germany, Spain, and UK. The findings illustrate that firms valueing external information flows are more likely to co-operate, spanish firms collaborate to overcome risks and financial constraints, and public support is positively related to engaging in collaborative innovation.

Camarinha-Matos et al. (2009) describe the key concepts related to Collaborative Networked Organizations (CNO), classify the collaborative networks and provide application cases. The authors conclude with remarks on the key challenges and further discussion.

Nieto and Santamaria (2007) explain the role of different models of collaborative networks in achieving product innovations and their degree of novelty on a dataset composed of Spanish firms in a longitudinal study. Their findings reveal that collaboration with partners has negative effect, while the greatest positive impact comes from networks comprising of different types of partners (generation of new ideas, diversity).

Weaver (2008) explains how collaborative pull innovation has induced a fundamentally new dynamic in innovation processes and remark that the new form of innovation aims at fulfilling consumer demand judging from a dataset in food sector.

Vrande et al. (2009) discuss the motives and perceived challenges of SMEs when adopting open innovation practices. The authors measure open innovation on 8 innovation practices and analyze a dataset from 605 innovative SMEs from Netherlands. Their findings demonstrate that the medium sized firms are more engaged in open innovation practices compared to smaller firms, SMEs use open innovation for practical purposes, like meeting customer demands or keeping up with the competition in the market, and the most important challenges are organizational and cultural issues.

Zeng et al. (2010) investigate the relationship between cooperation networks and innovation performance of SMEs, by conducting SEM on 137 Chinese manufacturing SMEs. The authors' findings demonstrate that the Inter-firm cooperation has the most positive impact, cooperation with government agencies do not demonstrate significant impact, and the cooperation with customers, suppliers and other firms are more important than research institutions, universities or colleges and government agencies.

Elmquist et al. (2009) conduct an extensive literature research on open innovation concept. The authors study the academic papers and books on open innovation until November 2007, and the contribution of 9 researchers on the subject for further research. The novelty of this work is that it constitutes a comprehensive review of open innovation to understand the key concepts on a wider perspective.

Serrano and Fischer (2007) elaborate on how high-tech systems aid collaborative innovation in enterprises.

CHAPTER 4

INNOVATION MODEL AND HYPOTHESES

The ultimate purpose of a commercial organization today is to sustain a profitable business and excel in the corporate world. With increasing emphasis placed on innovation in the last decade, companies are constantly striving for ways to generate innovation to boost their innovative capabilities. Consequently, enhanced innovative skills yield strong competitiveness and sustainable profitability for a company. In innovation literature, a great number of studies are conducted in order to be able to accurately define factors that assess the innovative capabilities, which are also presented in Chapter 2.

In this chapter, an innovation model is presented with six innovativeness drivers and their contents, and the hypotheses developed are proposed.

4.1 Drivers of Innovativeness Model

The drivers of innovativeness model proposed in this section demonstrate the relationships among the innovation elements. Judging from the recent literature research provided in Chapter 2, most of the innovation-backed research that supports large corporations or SMEs are conducted within the neighbourhood of these determinants of innovativeness. **Figure 4.1** provides an overview for the 6 determinants of innovativeness and their components that are developed and analyzed in this thesis. The model incorporates intellectual capital, organizational structure, organizational culture, barriers to ınnovation, monitoring, and collaborations. These determinants are explored further in the following chapters of this thesis. The innovative capability of a given firm is measured along the six dimensions in **Figure 4.1**.

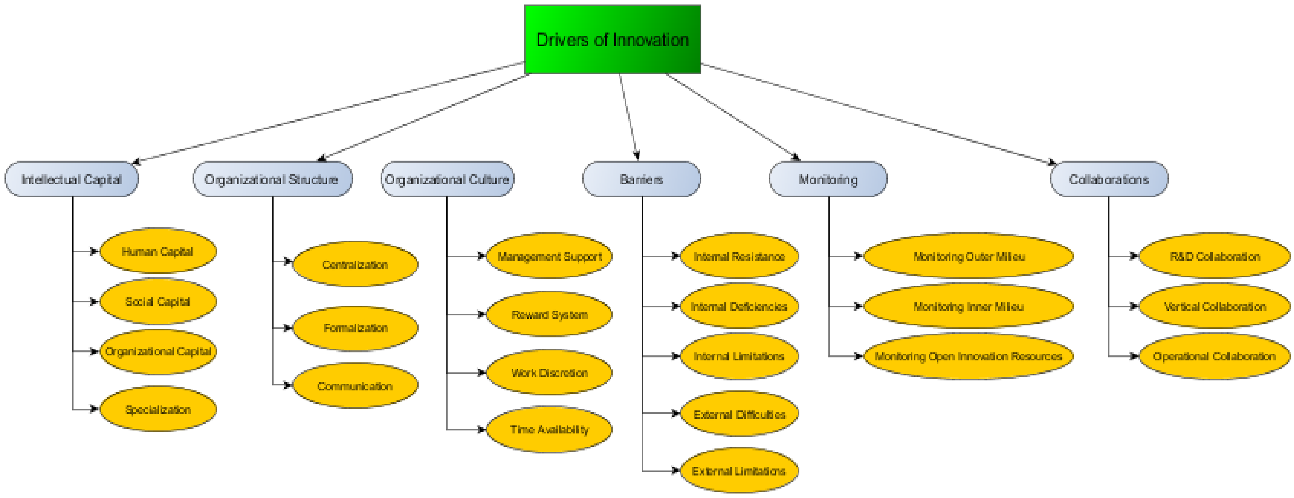


Figure 4.1. Drivers of Innovativeness Model

Since measuring overall innovativeness requires taking many factors into consideration, it is of vital importance to assess and evaluate each and every driver of innovativeness in the model. A combination of these drivers provide the innovativeness score for each firm as well as constitutes the basis for individual assessment. The accumulative innovative success in a company depends largely on the extent to which each driver of innovativeness contributes to the end result by interacting with other drivers and providing marginal benefit for the firm.

Intellectual capital is a valuable concept to contribute to the companies for their innovative endeavours. Since firms are run by simple accumulative know-how and information stock by its staff and managers, it is appropriate to invest on the intellectual capital continuously. The employees and managers generate ideas, know-how and projects that will eventually contribute to innovative activities of the company and benefit the firm in the long run. Edvinson (1977) distinguishes intellectual capital under three dimensions. These are human capital, social capital, and organizational capital. In this thesis, we consider the specialization component of the intellectual capital as well that was previously studied in Walker et al. (1987).

Human capital is the direct result of the individuals' aggregate capability to produce know-how, entertain new ideas and come up with bright insights in a firm. The related questions in the survey were directed towards measuring the perception of staff qualification, creative thinking and proficiency at work.

Social capital is a combination of the intercommunication and bilateral activities among the employees to exhibit team work and perform tasks better compared to their individual self. The questions in the survey aimed at measuring the capabilities of problem solving, information flow among the departments and the supplier-customer match.

Organizational capital is the product of all documented and classified organizational know-how, process management and organizational practices. Handbooks, databases, process documentations and administrative flowcharts are examples of this definition.

Specialization measures the perception of how experienced the staff is in the domain they are working.

Organizational structure is composed of three groups: centralization, formalization, and communication. Centralization measure investigates the level of hierarchy and authorization within the firm. Formalization questions seek to investigate the clarity of the work instructions, the level of bureucracy, the existence of assisted guidance and the amount of incentive taking within the firm. Communication group of questions analyzes the extent of vertical and horizontal communication and how effective the inter-departmental information flow is.

Organizational culture is a vital driver of innovativeness as it seeks to assess how much the firm is encouraging innovative activities. This driver is measured on several items, and these are management support, reward systems, work discretion and time availability. The management support consists of elements such as how much the administration attaches importance to individual encouragement for innovative activities, how much it supports free thinking environment and creates a sustainable environment for innovation. The reward systems should exist in the firms in order to incentivize employees to engage in innovative activities. The rewards are to a large extent based on innovative performance. The workers exhibiting extraordinary achievements in terms of innovativeness should be considered for promotion as an incentive. Such employees should also be rewarded with extended responsibilities and authorization. The company culture should appreciate engagement in innovative endavours in order to increase the overall profits obtained from innovative ideas.

Barriers to innovation in a company are either internal or external. The internal barriers can be summarized as internal resistance, internal deficiencies and limitations, whereas external barriers can be listed as external difficulties and limitations. Internal resistance generally means that the corporation lacks a climate that generates tendency to think innovatively, and/or the corporate missions and visions are vague and fuzzy which do not allow innovation. Internal deficiencies can be ennumerated as the lack of technical experience and know-how, and the lack of qualified staff to either generate or actualize innovative ideas. Internal limitations are time restrictions, the routine workload and the insufficient auditing. On the other hand, there are two actors which act as the barriers to innovation in a firm that are not within the corporate domain, and these are external nature. External difficulties generate mostly from the lack of a robust government R&D policy, and the external limitations from the lack of sizeable and thriving economy.

Monitoring innovative activities is crucial for the firm to keep up-to-date about the recent developments within innovation domain. The firms should at all times monitor the inner milieu, the outer milieu and the open innovation resources. The in-house innovation can be generated through investigating the nature of relationships among customers, suppliers and vendors. An overview of the entire supply chain operations might yield fruitful results that will result in innovations that will lead to incremental or radical improvements. On the other hand, it is of extreme importance to keep a keen eye on the rivals to extract the know-how that can be beneficial to succeed. Monitoring should not be limited to rivals but should include firms from different sectors as well. Open resources should be monitored and utilized for increased innovative performance. Open resources can be considered as developments in the university research centers, annual exhibitions or publications and periodicals.

Innovative collaborations can be conducted as R&D collaboration, vertical collaboration and operational collaboration. R&D collaboration incorporates collaboration with research centers and universities, competitors and the other firms excluding the suppliers and the customers. Vertical collaboration is the integration of suppliers and customers into the innovative thinking process, while operational collaborations involve collaborative activities in production, service/delivery/sales and training.

The four different innovation types as presented in the Oslo Manual (2005), namely; product, process, marketing and organizational innovation were utilized as aggregate measurement units, and the corresponding questions were asked for each driver acccordingly.

4.2 Hypotheses

In this section, hypotheses on the drivers of innovativeness and the performance factors are developed for statistical significance investigation. The null hypothesis states that there is no statistical significance among the cluster means of either the drivers of innovativeness or the performance factors. Hypotheses H1 to H6c are developed for testing purposes as can be seen in **Table 4.1**. Each individual hypothesis investigates the possibility of a statistical significance among the clusters, either overall or pairwise, that can be interpreted leading to possiblle results. These statistical significance results are obtained either with ANOVA or Kruskal-Wallis tests for mean comparisons depending on the results of the normality tests (*p*-values).

As mentioned earlier in this thesis, these factors were measured on a 1-5 Likert Scale where applicable. Mean and standard deviation scores are computed and the normality tests were performed in order to determine the normal or non-normal nature of the distributions of the parameters, which will lead to either parametrical tests or non-parametrical tests. The tests for all of the measures are performed using IBM SPSS v.20. The results for normality tests, as well as mean comparison tests can be found in Chapter 6 under the hypothesis testing results section.

Table 4.1. Hypotheses Development

#	Hypothesis	#	Hypothesis
H_1	Intellectual Capital	H_4	Barriers to Innovation
H_{1a}	Human Capital	H_{4a}	Internal Resistance
H_{1b}	Social Capital	H_{4b}	Internal Deficiencies
H_{1c}	Organizational Capital	H_{4c}	Internal Limitations
H_{1d}	Specialization	H_{4d}	External Difficulties
H_2	Organizational Structure	H_{4e}	External Limitations
H_{2a}	Centralization	H_5	Monitoring
H_{2b}	Formalization	H_{5a}	Outer Milieu
H_{2c}	Communication	H_{5b}	Inner Milieu
H_3	Organizational Culture	H_{5c}	Open Innovation Resources
H_{3a}	Management Support	H_6	Collaborations
H_{3b}	Reward System	H_{6a}	R&D Collaboration
H_{3c}	Work Discretion	H_{6b}	Vertical Collaboration
H_{3d}	Time Availability	H_{6c}	Operational Collaboration

Normality results, and the chosen test are provided in the succeeding chapters. When a statistical significance ($p<0.05$) is detected, it is concluded that the data is not normally distributed, and a Kruskal-Wallis test is applied for mean comparison. On the other hand, when the normality test resulted in higher *p*-values ($p>0.05$), it is concluded that the data is normally distributed, and a one-way ANOVA test is performed in order to test whether there is a statistically significant observation among the clusters, both overall and pairwise. Statistical results can be found in chapter 6.2, while the comments and interpretations are concluded in the summary section of Chapter 7.1.

CHAPTER 5

METHODOLOGY AND ANALYSES

5.1 The Design of the Questionnaire and the Measurement of Variables

For investigation purposes, a questionnaire with 311 individual questions were prepared and submitted to upper managers of manufacturing companies in 6 distinct industries, namely textile, chemical, metal products, machinery, domestic appliances and automative industries. The questionnaire was designed to assess the firm's business strategy, innovativeness degree, competitive priorities, market and technology strategy, existing market situation and overall corporate performance and it was constructed in the neighbourhood of the proposed model.

The measurement of the variables was achieved as follows (Ulusoy et al., 2014).

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 research (Khazanchi et al., 2007).

The scales of the four different manufacturing strategies' measures are adapted from existing operations management (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.

The numerical responses to the questions were averaged out to obtain the mean values, which were used to represent the variable associated with the measurement unit.

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 is true for the marketing and technology strategies.

5.2 Data Collection

For investigation purposes, a questionnaire with 311 individual questions were prepared and submitted to upper managers of manufacturing companies in 6 distinct industries, namely textile, chemical, metal products, machinery, domestic appliances and automative industries. The questionnaire was designed to assess the firm's business strategy, innovativeness degree, competitive priorities, market and technology strategy, existing market situation and overall corporate performance and it was constructed in the neighbourhood of the proposed model.

The initial survey went through a pilot study consisting of 10 interviews to ensure the appropriability of formatting, wording and sequencing of the questions. Further information on data gathering stage can be found in Günday et. al (2011).

The dataset was obtained over a 7-month period. As a result of the diversity of the organizational structures, manufacturing business units were selected as the unit of analysis.

A total of 1674 firms were randomly selected in accordance with the number of firms represented the size of the sector and the province. 184 useful questionnaires were obtained, resulting in a response rate of 11%. All the respondents completing the questionnaire were from the top (52%) or middle management (48%).

The profile of the sample is represented in **Figure 5.1**. Firm size was determined by the number of full-time employees (up to 50: small, between 50 and 250: medium, more than 250: large) and the firm age was determined by the year the firm started production (older than 1975: old, between 1975 and 1992: moderate, younger than 1992: young).

After the data collection stage, multivariate statistical analyses via SPSS v20 software package were conducted in order to validate the research framework. Missing data points were handled by the random distribution (MAR) on items and they were deleted by list-wise deletion. Control variables were investigated on age, size, foreign capital and legal status in terms of statistical significance and no statistical evidence was spotted.

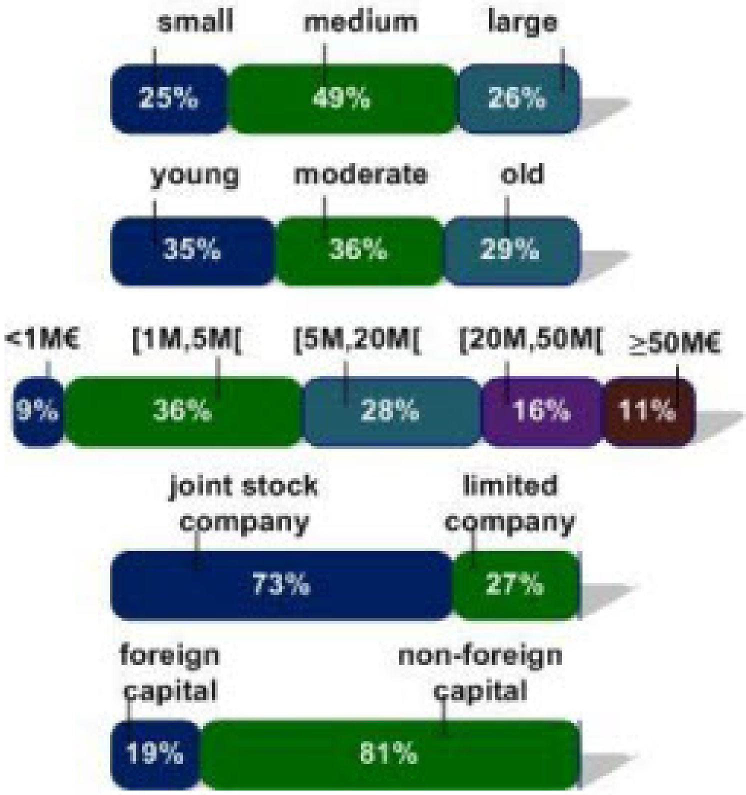


Figure 5.1. Data Sample Profile (Günday, 2011)

Figure 5.1 represents the data sample profile. The figure reveals the distribution of companies in terms of firm size, firm age, revenues, firm legal status and the capital investment. Furthermore, the detailed description of the data sample can be found in Gunday et al. (2011).

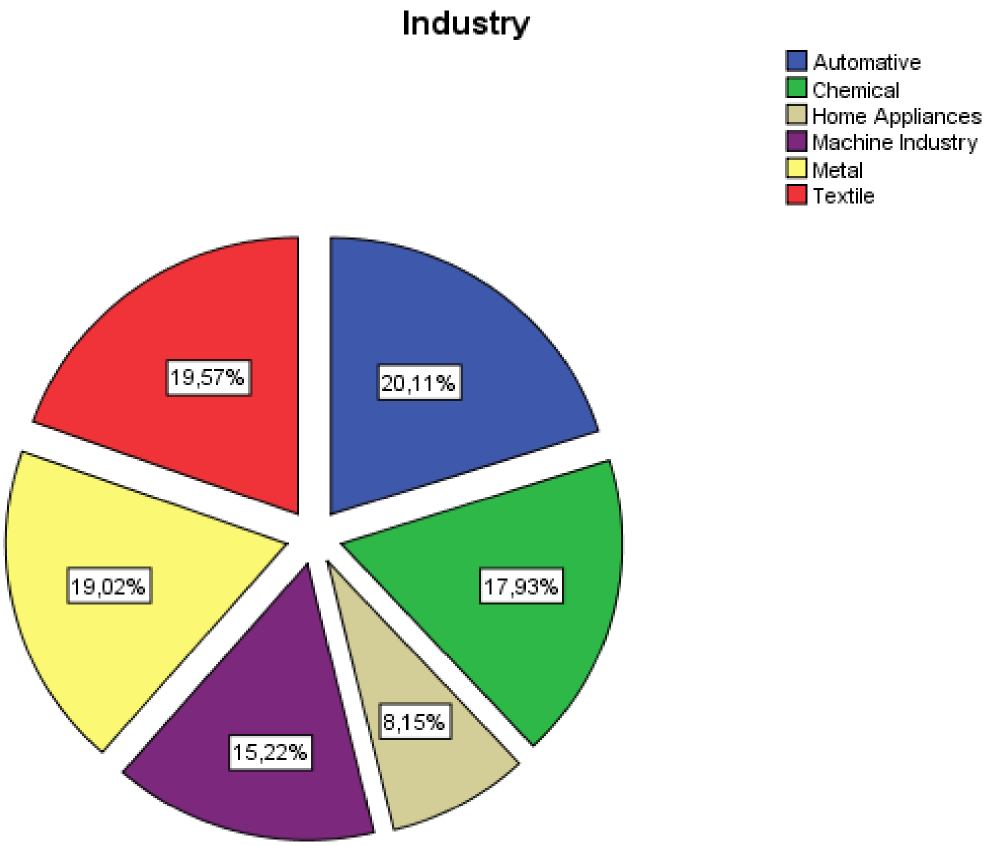


Figure 5.2. Industry Profile

Figure 5.2 displays the distribution of the industries on the dataset. The distribution of industries on the dataset emerges as below:

- Textile (19,6%)
- Chemical (17,9%)
- Metal (19%)
- Machine Industry (15,2%)
- Domestic Appliances (8,2%)
- Automotive (20,1%)

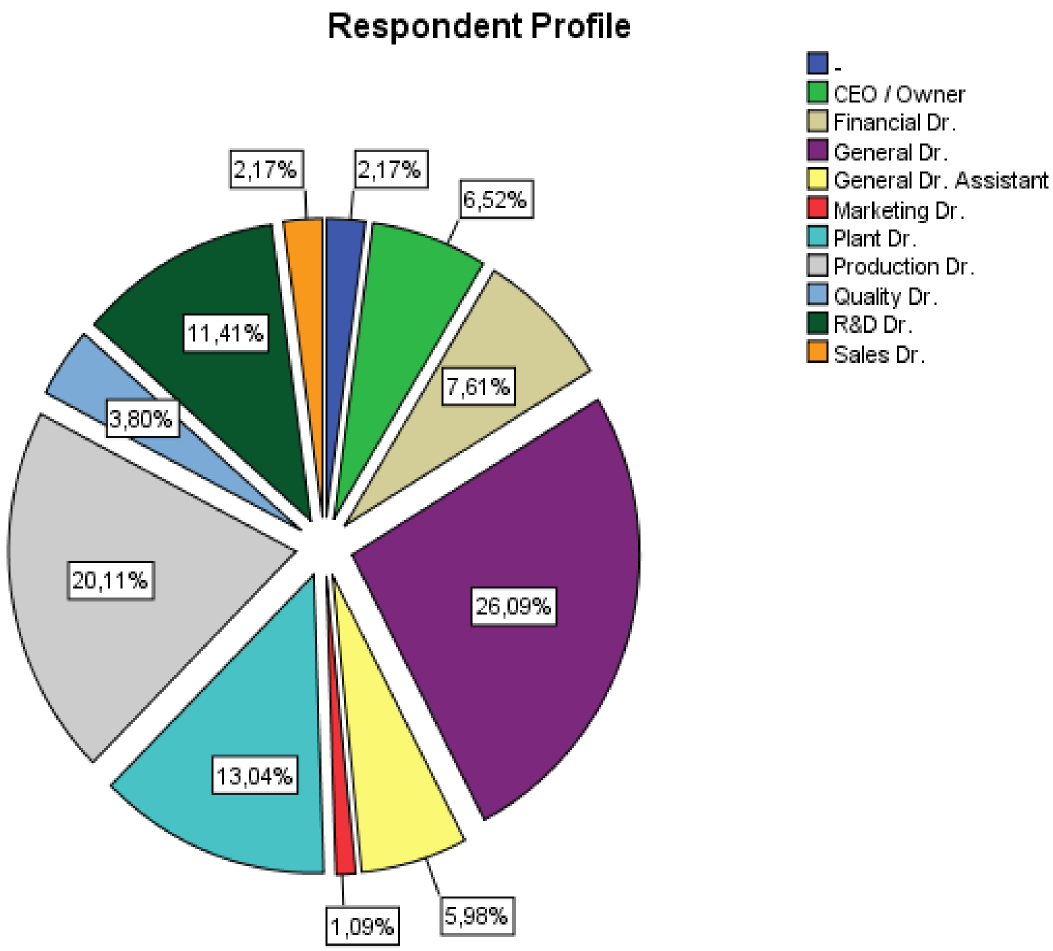


Figure 5.3. Respondent Profile

Figure 5.3 displays the distribution of the respondents on the dataset, where 2.17% of respondents did not specify their title. Respondents title were various, including the CEO/Owner of the firm, Financial directors, general directors, general director assistants, marketing directors, plant managers, production directors, quality assurance directors, R&D directors and sales directors. The respondents are mostly selected from business development or research and development departments, where innovative activities are predicted to take on highest number of occurances and the representation of the firm is considerably accurate.

5.3 Statistical Methods

In order to identify the statistical relationships among the innovativeness drivers, the initial step is to determine whether the data points in each group are distributed normally or not. The first important decision was whether to choose parametric or non-parametric statistical tests (Conover, 1998). For this purpose, normality tests are performed. Parametricality and non-parametricality of the sample points are commented. Since parametric tests are applicable only when the distribution exhibits a parameterized distribution like normal distribution, they were not applicable in all the cases in our study. The widely used Shapiro-Wilk test was applied to test whether the samples follow normal distributions or not (Shapiro and Wilk, 1965).

The parametric t-test, and the non-parametric Wilcoxon rank-sum test (also known as the Mann–Whitney U test; Mann and Whitney, 1947) could not be used for testing the statistical significance of the differences in the means. These two tests are used when there are only two samples to compare. In our case of multiple clusters, either ANOVA (when normally distributed), or a Kruskal-Wallis test (when non-normally distributed) were performed depending on the normality results of the samples.

Kruskal-Wallis test does not make assumptions on the normality of the data, since it is a non-parametric test, ANOVA test, on the other hand, expects the inputs to be normally distributed. Similar to Wilcoxon rank-sum test, Kruskal-Wallis test is performed on ranked data, so the data points are attached a ranking value in accordance with the overall dataset. One-way anova analysis does not request ranked input data, since the variables are nominal and assumed to exhibit normal distribution. The Kruskal-Wallis test does not test the null hypothesis that the input samples have identical means, that is the null hypothesis for one-way ANOVA test. Even though Kruskal-Wallis test does not assume normal distribution and this fact makes the test powerful, it should be noted that the test assumes that the observations in each group exhibit the same shape of distribution, thus neglecting skewness which may provide inaccurate results, as discussed by Fagerland and Sandvik (2009).

Gaten (2010) lists the data types that can be used with the Kruskal-Wallis test. He remarks that the data points must be independent from each other, the distributions do not have to be normal and the variances do not have to be equal, ideally there should be more than five data points per sample, all individuals must be selected at random from the population, all individuals must have equal chance of being selected, and the sample sizes should be as equal as possible but with some differences allowed.

In order to investigate the DEA efficiency scores, a Spearman Correlation Analysis (Spearman, 1904) was performed, and the results are provided in the DEA chapter. Spearman tests displays a positive correlation between two measures when the resulting rho values are between 0 and 1, and a negative correlation when the values are between 0 and -1.

5.4 Cluster Analysis

A hierarchical procedure based on Ward"s agglomerative method was used with squared Euclidian distance measure. As a stopping rule, the elbow criterion was implemented (Hair, Anderson, Tatham and Black, 2006). The cluster analysis yielded 4 distinct clusters and consequently these clusters were examined in terms of their mean differences and thus, possible managerial insights.. The clusters obtained in this section were grouped as follows: Followers(82 firms), Inventors (35 firms), Leading Innovators (41 firms) and Laggers (22 firms). 4 firms were excluded from the analysis due to incomplete data, and these are firms numbered 1, 114, 143 and 183 respectively.

Having formed the clusters, a statistical mean comparison is performed for these four groups. Overall mean comparisons, as well as pairwise mean comparisons are provided in the chapters following this one. The results are tabulated and visualized in box-plots. The comparisons in the next chapter necessitated one-way ANOVA test with Bonferroni post-hoc pair-wise (Bonferroni test adjustment is utilized because it constitutes a general approach as corrective measures for overall error when there are irregularities or missing points in the data, and it also aids in conrtoling Type-1 error) comparison or Kruskal-Wallis mean comparison testing for the purpose of determining which clusters distinguished themselves from the others in a statistically significant manner, in terms of the aforementioned six determinants of innovativenes.

The clusters were categorized through a naming convention that is suitable for each cluster. In accordance with OECD’s classification of innovation. As an addition to OECD’s

(2005) four groups, we have further dissected product innovation into incremental product innovation and radical product innovation in order to have a more accurate analysis. The clusters are obtained in terms of their incremental product innovation, radical product innovation, process innovation, marketing innovation and organizational innovation. These clusters were then named Leadering Innovators, Followers, Inventors and Laggers respectively.

Leading Innovators are the top firms that have a robust reputation in being innovative, and they outperform the other 3 clusters in all domains of the 5 definitions of innovation. Followers pursue the innovativeness road that is paved by the Leading innovators and benefit from immitating the innovation. They are better off than Inventors and Laggers in all domains except radical product innovation. Even though Inventors are ahead of the Followers in terms of radical product innovation, it falls short in other domains and is only better off than the Laggers. Laggers perform the worst regarding all the innovation definitions.

5.5 Data Envelopment Analysis (DEA)

DEA is a highly effective methodology that can be implemented in order to benchmark a group of entitites, through efficiency scores (Cooper et al., 2006). Through the results of DEA, managers are able to gain actionable insights and improve the overall performance of their organization. As a performance measuring tool, the use of DEA has been popular in the literature. There exist various applications of DEA, and Gattoufi et al. (2004a) provide a classification scheme for the DEA studies in literature, based on data source, type of implemented DEA model, analysis, and the nature of the paper. The contents of the studies in the DEA literature are discussed in another paper by Gattoufi et al. (2004b).

Calculations of efficiency scores are based on the values of inputs and outputs for the entities, which are referred to as Decision Making Units (DMUs). Inputs, are the resources consumed by the DMUs, for generating desired outputs. Efficiency score, which takes a value between 0 and 1, increases as a DMU can generate higher values in any of the outputs when the input values are the same, or when a DMU can generate the same values in the outputs when any of the input values is lower.

In our study, the 6 drivers of innovativeness (Intellectual Capital, Organizational Structure, Organizational Capital, Barriers to Innovation, Monitoring and Collaborations) were considered as inputs and the single dimension innovativeness was considered to be the output for the DMUs. It is reasonable to reduce these 6 dimensions into 1 dimension in order to evaluate the level of innovativeness on a single metric. Since the input values can not be changed, the goal of a DMU is to increase the values of its outputs. The values for each driver of innovativeness are measured on a 1-5 Likert scale, and can not take negative values. As a result of the input values being constant, the objective of a DMU is to increase the values of its outpus, which interprets to the necessity of an output oriented model. This perspective is reflected in the selected DEA model, which is the output-oriented BCC model (BCC-O). In this research, an interactive open source DEA modelling software, SmartDEA Solver (Akcay et al., 2012), has been extensively used. As a result of the DEA analysis, the multi dimentional evaluation for the 6 criteria is expressed in a single dimension, that is the efficiency score for each firm. The efficiency score for a firm represents the overall innovativeness of that firm with respect to the 6 drivers of innovativeness.

CHAPTER 6

RESULTS

In this chapter, the results of analyses are provided and commented upon.

Sub-sections under Chapter 6.1 display the cluster analysis results, sections under Chapter 6.2 provide the hypothesis testing results, while Chapter 6.3 concludes Chapter 6 with the DEA results.

Figures related to clusters are provided and groupings are commented upon. Unique positioning of the four clusters, namely Leading Innovators, Followers, Inventors and Laggers are displayed in the visuals. Mean comparison tests and statistical investigations are conducted and the resulting significance values are given in the chapters below. DEA analysis provided efficiency scores that signify the relative efficiency scores of each firm in our dataset compared to the others in terms of input and output relationship. The figures were obtained in terms of clusters obtained in the cluster analysis and elaborated further.

6.1 Cluster Analysis

The cluster analysis explained in Chapter 5.3 with specific configurations is performed and the cluster analysis in TUBITAK coded 105K105/SOBAG (2007) is replicated here to verify the results obtained earlier. The groups are labeled as the Followers(82 firms), Inventors (35 firms), Leading Innovators (41 firms) and Laggers (22 firms) and are distinctive from each other as found out in Günday et al. (2010). **Figure 6.1** represents the distribution of the clusters to the industries considered.

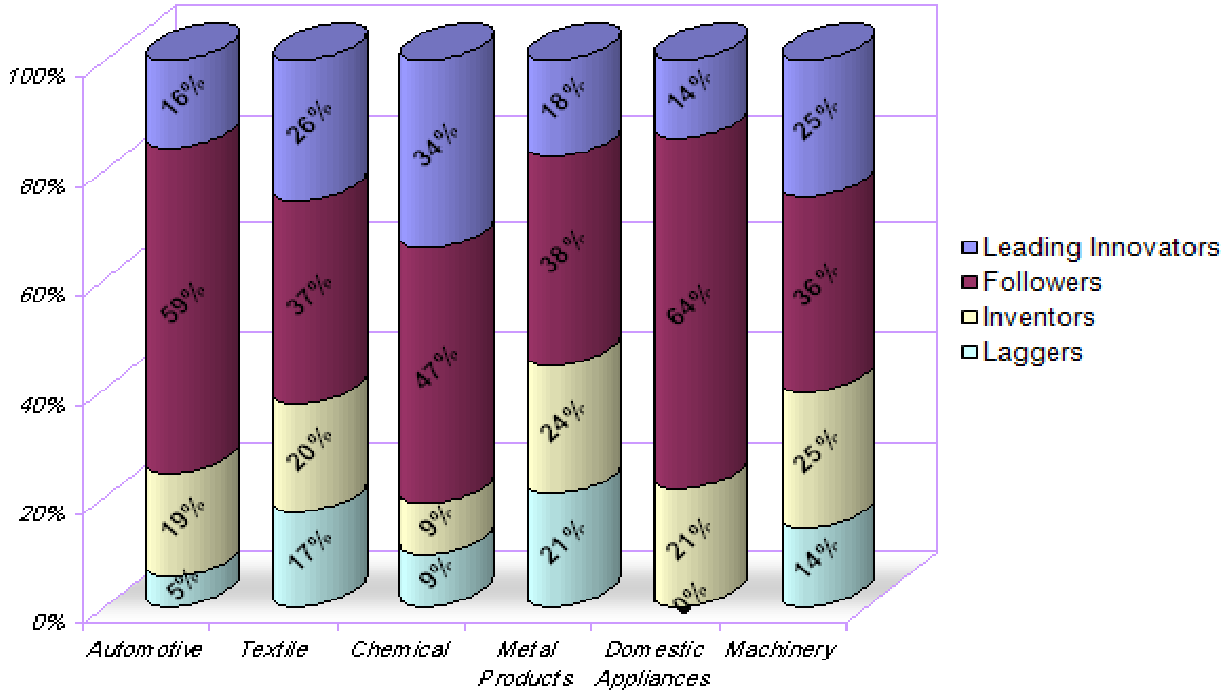


Figure 6.1. Distribution of Clusters to Industries (Günday et al., 2010)

The Leading Innovators are distributed to the six industries as, textile (26%), chemical (34%), metal (18%), machine industry (25%), domestic appliances (14%), automotive (16%). Followers are distributed as, textile (37%), chemical (47%), metal (38%), machine industry (36%), domestic appliances (64%), automotive (59%). Inventors are distributed as, textile (20%), chemical (9%), metal (24%), machine industry (25%), domestic appliances (21%), automotive (19%). Laggers are distributed as, textile (17%), chemical (9%), metal (21%), machine industry (14%), domestic appliances (0%), automotive (5%). It is worth remarking at this point that there are no firms in our dataset belonging to domestic appliances industry.

6.1.1 Incremental Product Innovation

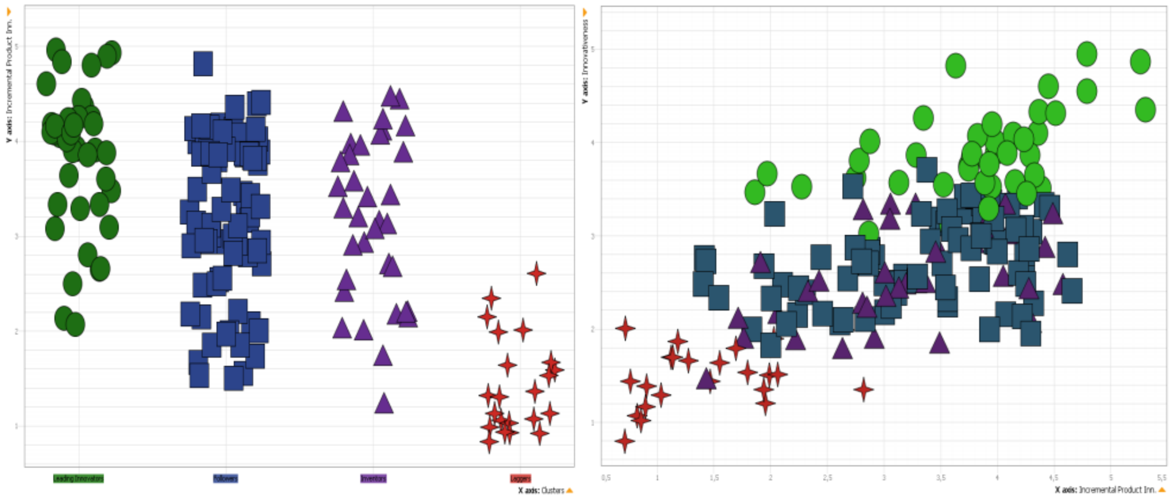


Figure 6.2. Incremetal Product Innovation (Günday et al., 2010)

As can be seen in **Figure 6.2**, there is a clear distinction between the four clusters in terms of the incremental product innovation. In the figure, green color denotes Leading Innovators, blue Followers, purple Inventors and red Laggers. The labels given to the clusters (Leading Innovators, Followers, Inventors and Laggers) match with the incremental product innovation results. Leading Innovators are extremely successful in coming up with incremental product improvement ideas, while the Laggers are apparently lacking the capacity to produce additional changes on the products.

6.1.2 Radical Product Innovation

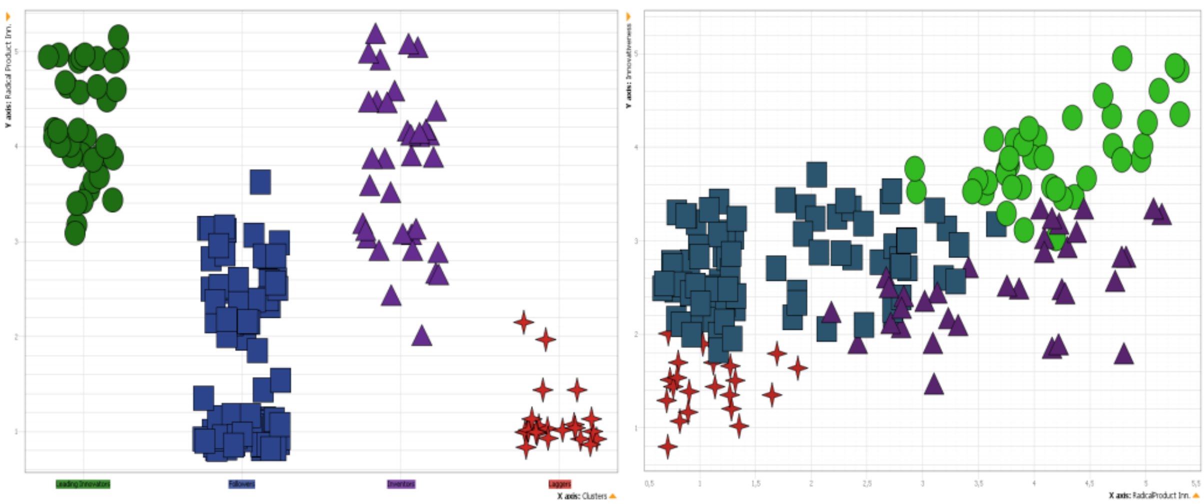


Figure 6.3. Radical Product Innovation (Günday et al., 2010)

Figure 6.3 also presents a distinct grouping of the four clusters in radical product innovation with the same color scheme. It is worth noting that the cluster with the highest levels of radical product innovations are the Leading Innovators, while the cluster with the lowest is found to be the Laggers. Inventors are successful at generating radical product innovations and are therefore labeled accordingly.

6.1.3 Process Innovation

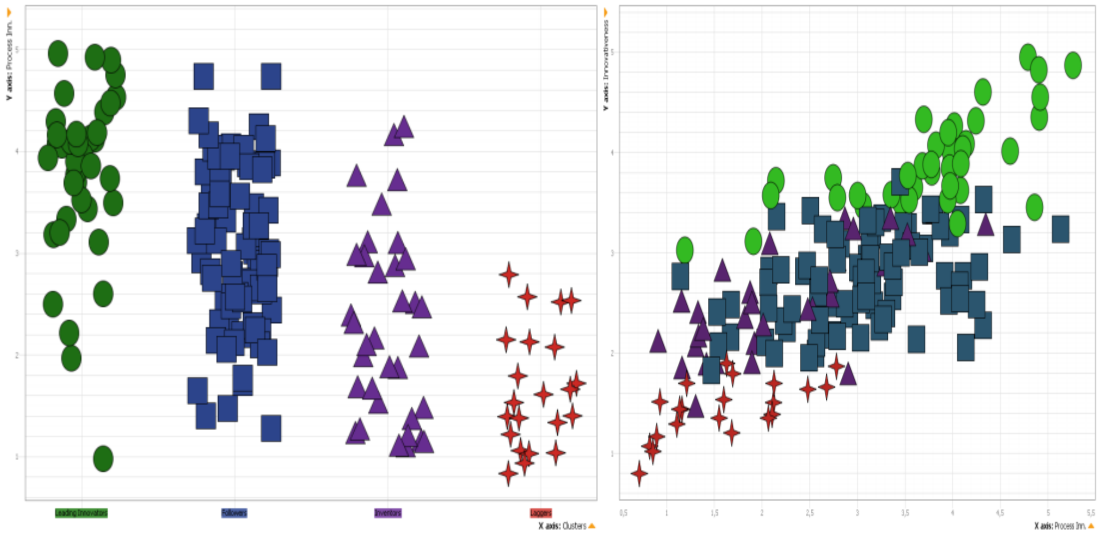


Figure 6.4. Process Innovation (Günday et al., 2010)

Figure 6.4 displays the process innovation capabilities of each cluster. The unique positioning of the clusters relative to each other is once again visible in the figure. With a few exceptions scoring low process innovation performance, Leading Innovators are again the group with the highest innovation performance scores. The Laggers are preceeded by the Followers and the Inventors in terms of process innovation performance.

6.1.4 Market Innovation

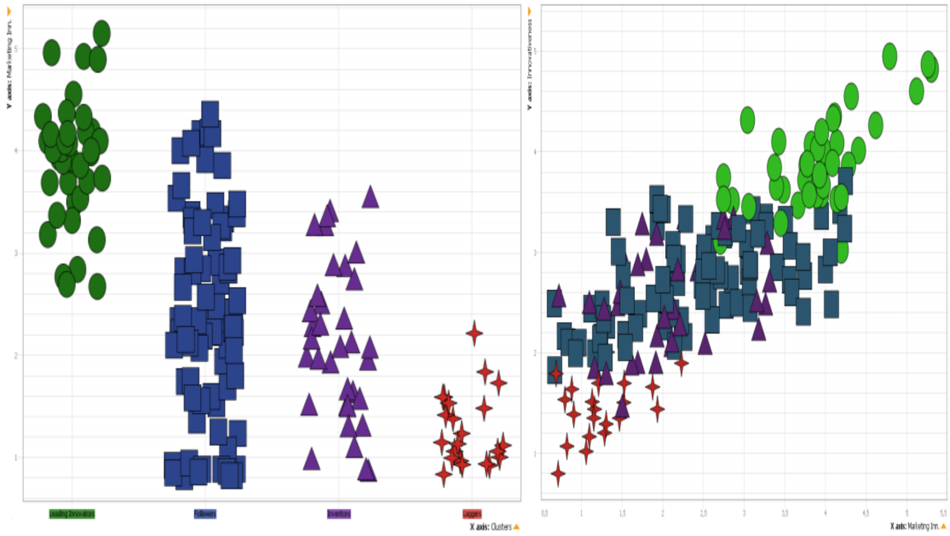


Figure 6.5. Market Innovation (Günday et al., 2010)

Figure 6.5 demonstrates the market innovation capabilities of each cluster. The unique positioning of the clusters relative to each other is once again visible in this figure. The Leading Innovators is the cluster with the highest market innovation scores, while the Laggers perform the lowest scores. It is noteable that the Followers denoted by the blue squares have a wider range of variation in market innovation.

6.1.5 Organizational Innovation

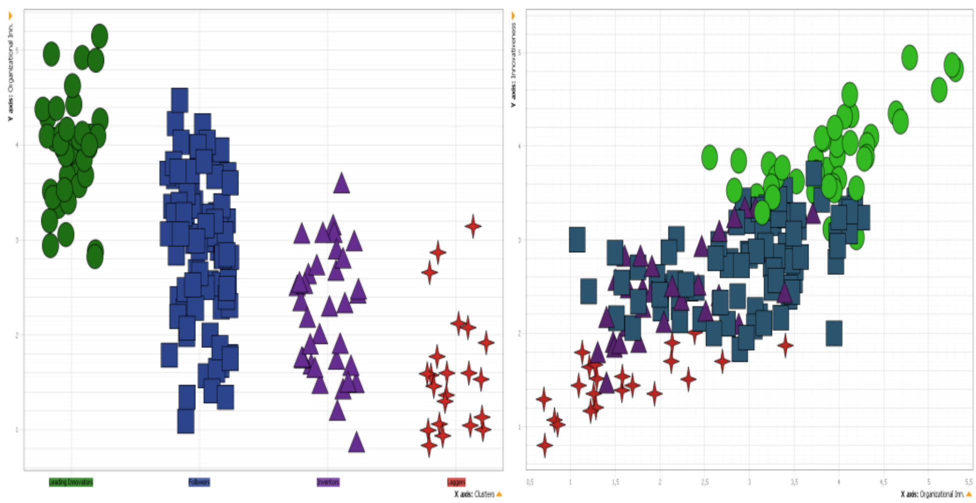


Figure 6.6. Organizational Innovation (Günday et al., 2010)

Figure 6.6 displays the organizational innovation scores for each firm in 4 clusters. The distribution of the firms in different clusters is similar to the previous distributions obtained for the other innovation types. Once again, the firms in the Leading Innovators cluster lead the others, and the firms in the Laggers cluster trail the others.

6.2 Hypothesis Testing

In this section, statistical significances among clusters obtained in Chapter 6.1 are examined. Each section in this chapter is provided with the tabulated results of the normality tests and the following overall and pairwise mean comparison tests.

Normality results were interpreted in accordance with a certain rule, that is when *any* of the clusters exhibits statistical significance ($p<0.05$) for a given innovation driver or a component of an innovation driver, it is assumed to be non-normally distributed and non-parametric mean comparison test Kruskal-Wallis is performed, otherwise when *each and every one* of the clusters exhibits no statistical significance ($p>0.05$), the test is assumed to distribute normally and the parametric one-way ANOVA test was performed for multiple mean comparisons.

Chapters 6.2.1 displays the normality and variance testing results for the drivers, while Chapters 6.2.2 to Chapter 6.2.7 display the results for the components for each driver tested among the four clusters.

6.2.1 Drivers of Innovativeness

The six drivers of innovativeness proposed as an integrated model framework in this thesis were tested in terms of their normality. **Table 6.1** displays the significance results, and which variance testing method is applied in accordance with the *p*-values as explained in Chapter 6.2. The red and underlined p-values under Shapiro-Wilk Significance column indicate the statistical significance, while the regular fonts provide no statistical significance. It is observed that among all the innovativeness drivers, only organizational structure has a normal distribution, and is tested using the ANOVA test, while the other five drivers exhibit non-normality to certain degrees and are tested with the non-parametric Kruskal-Wallis test.

Table 6.1. Drivers of Innovativeness Normality Test Results

Driver	Cluster	Shapiro-Wilk			TEST
		Statistic	df	Significance	
Intellectual Capital	Followers	.965	82	.024	Kruskal-Wallis
	Inventors	.956	35	.172	
	Laggers	.925	22	.097	
	Leading Innovators	.986	41	.890	
Organizational Structure	Followers	.989	82	.735	ANOVA
	Inventors	.980	35	.753	
	Laggers	.986	22	.982	
	Leading Innovators	.969	41	.330	
Organizational Culture	Followers	.974	82	.097	Kruskal-Wallis
	Inventors	.880	35	.001	
	Laggers	.963	22	.545	
	Leading Innovators	.979	41	.631	
Barriers to Innovation	Followers	.987	82	.554	Kruskal-Wallis
	Inventors	.906	35	.006	
	Laggers	.953	22	.354	
	Leading Innovators	.979	41	.626	
Monitoring	Followers	.957	82	.008	Kruskal-Wallis
	Inventors	.934	35	.036	
	Laggers	.913	22	.054	
	Leading Innovators	.926	41	.010	
Collaborations	Followers	.948	82	.002	Kruskal-Wallis
	Inventors	.925	35	.020	
	Laggers	.919	22	.071	
	Leading Innovators	.954	41	.096	

Notes: Underlined values indicate statistical significance at α=0.05.

Table 6.2. Drivers of Innovativeness Mean Comparison Results

Innovation Driver	Leading Innovators (Cluster 1)	Followers (Cluster 2)	Inventors (Cluster 3)	Laggers (Cluster 4)	F (or K)
Intellectual Capital					
Cluster Mean	3.868 (2,3,4)	3.436 (1)	3.260 (1)	3.291 (1)	34,615 <u>p<0.000</u>
Organizational Structure					
Cluster Mean	3.476	3.322	3.350	3.376	1,654 p<0.179
Organizational Culture					
Cluster Mean	3.673 (4)	3.385	3.300	3.144 (1)	11.739 <u>p<0.008</u>
Barriers to Innovation					
Cluster Mean	3.542(3)	3.514(3)	3.049(1,2)	3.373	11.294 <u>p<0.010</u>
Monitoring					
Cluster Mean	3.106 (3,4)	2.871	2.555 (1)	2.492 (1)	14,837 <u>p<0.001</u>
Collaborations					
Cluster Mean	1.458	1.400	1.392	1.300	5,885 p<0.117

Notes: Numbers in parantheses indicate the cluster groups from which this cluster is significantly different at α=0.05. Corresponding F and K values are based on ANOVA and Kruskal-Wallis tests. Underlined values indicate statistical significance at α=0.05.

Table 6.2 displays the variance testing results for each one of the six drivers proposed in this study. It is observed that there is a statistically significant difference among the four clusters in terms of their innovative capabilities on intellectual capital, organizational culture, barriers to innovation and monitoring dimensions, and these values are p=0.000, p=0.008, p=0.010, and p=0.001 respectively.. There exists no statistical significance in organizational structure and collaborations drivers, as their significance values are p=0.179, and p=0.117 respectively. On a pairwise comparison, the leading innovators differ from the other three clusters on a statistically significant level, suggesting that the leading innovators make a difference in additional investments on the intellectual capital. Meanwhile, there also exists a statistical difference between the leading innovators and the laggers on organizational culture. Barriers to Innovation performance driver also suggests a pairwise difference between the leading innovators, the followers and the inventors. On the other hand, monitoring driver exhibits a difference suggesting that the leading innovators are overwhelmingly attaching more importance to monitoring in-firm and out-firm resources of innovation compared to the inventors and the laggers.

6.2.2 Intellectual Capital

The four components of intellectual capital, the human capital, social capital, organizational capital and specialization as proposed in the integrated drivers of innovativeness model were tested in terms of their normality for each cluster group, and the significance results are tabulated in **Table 6.3**. The table also incorporates the type of variance testing method to be applied under the Test column in accordance with the evaluation of p-values explained in Chapter 6.2. The red and underlined p-values under Shapiro-Wilk Significance column indicate a statistical significance while the regular fonts provide no statistical significance.The table summarizes the p-values for normality tests conducted on Intellectual Capital factor. As a result of the higher p-values, human and social capital were comprehended to have normal distribution and parametric one-way ANOVA test was applied for mean comparisons. Depending on the relatively lower p-values that are underlined for Social Capital, Organizational Capital and Specialization factors, their distributions were assumed to be non-normal. For this reason, non-parametric mean comparison test Kruskal-Wallis was conducted on these three components, while the Human Capital component did not display statistical significance for any of the clusters and therefore required a one-way ANOVA analysis that takes a normallly distributed dataset as input.

Table 6.3. Intellectual Capital Normality Test Results

Component	Cluster	Shapiro-Wilk			TEST
		Statistic	df	Significance	
Human Capital	Followers	.976	82	.124	ANOVA
	Inventors	.969	35	.413	
	Laggers	.946	22	.260	
	Leading Innovators	.959	41	.147	
Social Capital	Followers	.969	82	<u>.046</u>	Kruskal-Wallis
	Inventors	.973	35	.544	
	Laggers	.944	22	.245	
	Leading Innovators	.961	41	.176	
Organizational Capital	Followers	.953	82	<u>.004</u>	Kruskal-Wallis
	Inventors	.956	35	.168	
	Laggers	.976	22	.839	
	Leading Innovators	.922	41	<u>.008</u>	
Specialization	Followers	.946	82	<u>.002</u>	Kruskal-Wallis
	Inventors	.968	35	.392	
	Laggers	.905	22	<u>.037</u>	
	Leading Innovators	.909	41	<u>.003</u>	

Notes: Underlined values indicate statistical significance at α=0.05.

Table 6.4. Intellectual Capital Mean Comparison Results

Intellectual Capital	Leading Innovators (Cluster 1)	Followers (Cluster 2)	Inventors (Cluster 3)	Laggers (Cluster 4)	F (or K)
Human Capital					
Cluster Mean	3.926 (2.3)	3.573 (1)	3.297 (1)	3.527	6.652 $p<0.000$
Social Capital					
Cluster Mean	3.985 (2,3,4)	3.602 (1)	3.377 (1)	3.445 (1)	20.626 $p<0.000$
Organizational Capital					
Cluster Mean	4.042 (2,3,4)	3.317 (1)	3.114 (1)	2.886 (1)	35.133 $p<0.000$
Specialization					
Cluster Mean	3.518 (2.3)	3.253 (1)	3.250 (1)	3.307	10.926 $p<0.012$

Notes: Numbers in parantheses indicate the cluster groups from which this cluster is significantly different at α=0.05. Corresponding F and K values are based on ANOVA and Kruskal-Wallis tests. Underlined values indicate statistical significance at α=0.05.

The cluster means of each resulting category in terms of the four performance factors of intellectual capital are tabulated in **Table 6.4** The one-way ANOVA analysis for Human Capital suggests that this component is significantly different among the clusters in terms of their cluster means, while the Kruskal-Wallis analysis for Social Capital, Organizational Capital and Specialization yield that these three components exhibit statistical significance depending on their cluster means. A striking observation obtained from **Table 6.4** is that the Leading innovators exhibit statistical significance in pairwise cluster mean comparisons compared to other three clusters, except human capital and specialization factors, where it does not exhibit a statistical significance compared to Laggers. The results prove that the perception of intellectual capital components are well grasped by the leading innovators, and they differentiate themselves in the industries with the emphasis they place on the Intellectual Capital.

Leading Innovators

The Leading Innovators consisting of 41 out of 180 companies outclass the other three clusters in every aspect of intellectual capital performance factors, even the specialization factor, where their mean score is the lowers (3.518). Leading innovators devote extreme significance to human capital, social capital, and organizational capital.

Followers

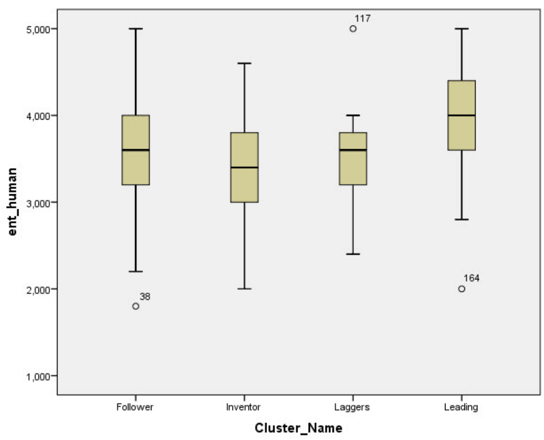
The Followers are arguably the second cluster with the highest intellectual capital scores, except for the relatively lower specialization factor mean they scored (3.253). Laggers seem to outperform the Followers in this performance factor, while the Inventors slightly lag behind in terms of mean values.

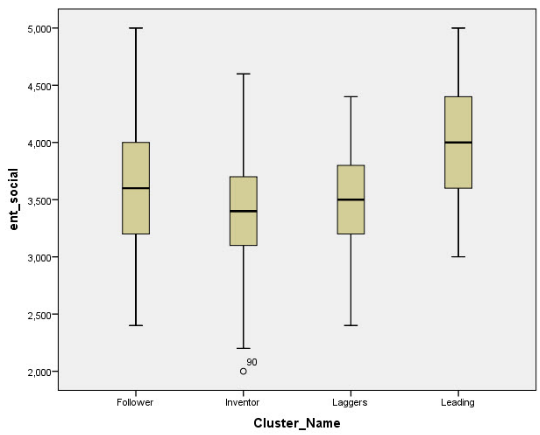
Inventors

As expected, Inventors fall behind the Leading Innovators and Followers in terms of the four performance factors of intellectual capital. One surprising remark to note here is that while inventors outclass the Laggers in terms of organizational capital and specialization factors, they are not able perform better in terms of human capital and social capital. This reveals that Inventors do not perceive these two factors to be crucial in order to improve their innovative capabilities.

Laggers

The Laggers cluster is the cluster that considers the intellectual capital to be the least important determinant of innovation.





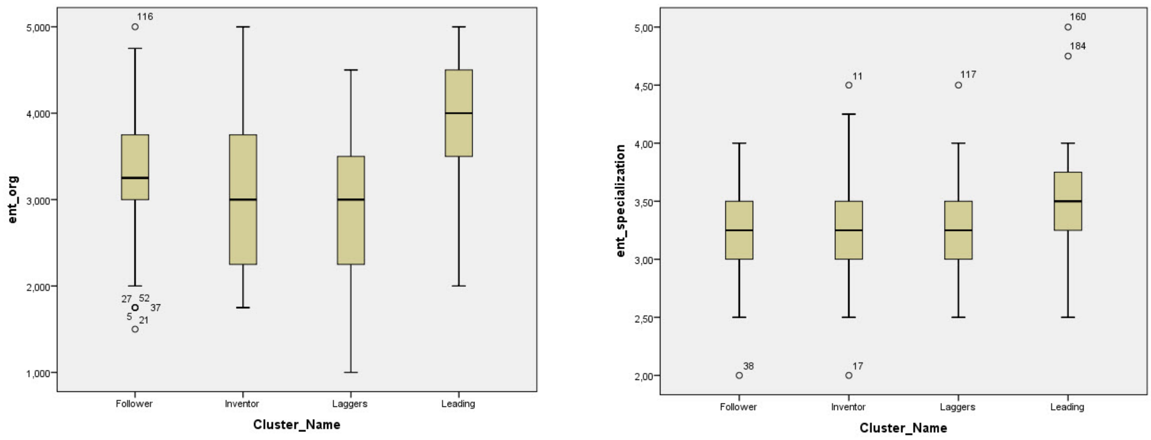


Figure 6.7 Box-plots of Intellectual Capital

Figure 6.7 presents the box-plots of the intellectual capital performance factors categorized in accordance with the innovation clusters. The vertical axes denote the intellectual capital performance factors of human capital, social capital, organizational capital and specialization, whereas the horizontal axes denote the cluster groups formed through cluster analysis.

6.2.3 Organizational Structure

Table 6.5 summarizes the p-values for normality tests conducted on Organizational Structure innovation driver. As a result of the higher *p*-values and no single entity with lower *p*-value at this confidence level α=0.05, Centralization and Formalization factors were assumed to have normal distribution and parametric one-way ANOVA tests were applied for mean comparisons. Depending on the relatively lower p-values in Communication factor (Inventors constituting an example with p=0.718), the distribution of communication groups was revealed to be non-normal. For this reason, non-parametric mean comparison test Kruskal-Wallis was conducted on this component.

Table 6.5. Organizational Structure Normality Test Results

Component	Cluster	Shapiro-Wilk			TEST
		Statistic	df	Significance	
Centralization	Followers	.983	81	.342	ANOVA
	Inventors	.969	35	.411	
	Laggers	.956	22	.420	
	Leading Innovators	.973	41	.429	
Formalization	Followers	.985	81	.477	ANOVA
	Inventors	.975	35	.595	
	Laggers	.979	22	.893	
	Leading Innovators	.971	41	.375	
Communication	Followers	.956	81	.007	Kruskal-Wallis
	Inventors	.979	35	.718	
	Laggers	.903	22	.034	
	Leading Innovators	.945	41	.045	

Notes: Underlined values indicate statistical significance at α=0.05.

Table 6.6. Organizational Structure Mean Comparison Results

Organizational Structure	Leading Innovators (Cluster 1)	Followers (Cluster 2)	Inventors (Cluster 3)	Laggers (Cluster 4)	F (or K)
Centralization					
Cluster Mean	2.792	2.616 (4)	2.945	3.166 (2)	3.344 <u>p<0.021</u>
Formalization					
Cluster Mean	3.495	3.361	3.233	3.371	0.949 p<0.418
Communication					
Cluster Mean	4.141	3.978	3.872	3.590	0.949 p<0.059

Notes: Numbers in parantheses indicate the cluster groups from which this cluster is significantly different at α=0.05. Corresponding F and K values are based on ANOVA and Kruskal-Wallis tests. Underlined values indicate statistical significance at α=0.05.

The cluster means, the pairwise comparisons and the related statistics of each resulting cluster in terms of the three performance measures of Organizational Structure are tabulated in **Table 6.6**. Statistical significance results prove a significance in centralization , and there exist no statistical significance in formalization and communication. On a pairwise comparison, there is no specific significance among clusters informalization and communication, whereas in centralization factor, Followers and Laggers are distinguished in terms of their means. As a remark, we can conclude from the significance values that the clusters vary significantly in terms of the level of hierarchy and authorization within the firm, particularly there is an important difference between Followers and Laggers.

Leading Innovators

The Leading Innovators outclass all the other clusters in all performance factors of organizational culture, except the centralization factor. It is observed that Leading Innovator firms have slightly less centralized structures within their organizations. They are more formal and the level of communication is relatively higher.

Followers

Follower firms are the least centralized firms (2.616), suggesting that these firms are less hierarchical and less authority dependent, creating a less centralized environment for innovation to emerge. Follower firms conduct more formal process based businesses compared to inventors, but are less formal than the Leading Innovators and Laggers. In terms of communication, Followers are more open to inter-department flow of information compared to Leading Innovators, but are less open when compared with Inventors and Laggers.

Inventors

Inventor firms are more centralized than Leading Innovators and Followers, but are less centralized than Laggers. In terms of formalization, Inventors are the least formal cluster (3.233) among the four clusters. This suggests that since Inventors are succesful as product innovators, there is less bureucracy, more assisted guidance and more incentive taking in these firms paving the way for creative ideas to proliferate.

Laggers

Lagger firms are the firms with least scores in communication (3.590), suggesting that the flow of information both vertical and horizontal within the firms are relatively weaker compared to the others. It is therefore understandable that these firms are lagging behind the other three groups of firms in all types of innovation, when the communication among employees is relatively low and the lack of interaction revealing itself as a weak point these firms should consider improving.

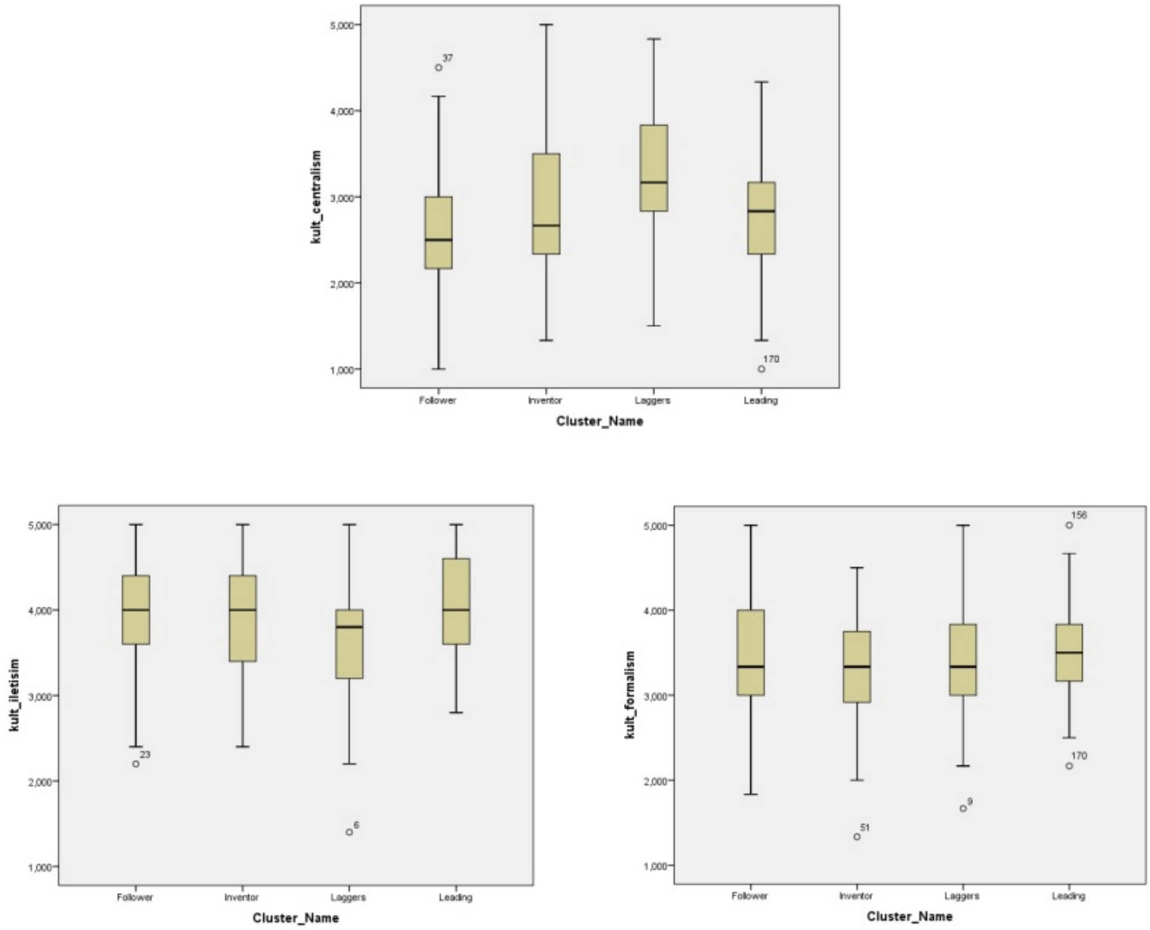


Figure 6.8. Box-plots of Organizational Structure

Figure 6.8 presents the box-plots of the organizational structure performance factors categorized in accordance with the innovation clusters. The vertical axes denote the organizational structure performance factors that are centralization, formalization and communication, whereas the horizontal axes denote the cluster groups formed through cluster analysis

6.2.4. Organizational Culture

Table 6.7 summarizes the *p*-values for normality tests conducted on organizational culture driver of innovativeness. As a result of the lower significance values obtained for all four components of organizational culture, their distributions among the clusters are taken to be non-normal. For this reason, non-parametric mean comparison test Kruskal-Wallis was conducted on these four factors.

Table 6.7. Organizational Culture Normality Results

Component	Cluster	Shapiro-Wilk			TEST
		Statistic	df	Significance	
Management Support	Followers	.978	81	.171	Kruskal-Wallis
	Inventors	.927	35	.023	
	Laggers	.958	22	.447	
	Leading Innovators	.966	41	.256	
Reward System	Followers	.949	81	.003	Kruskal-Wallis
	Inventors	.920	35	.014	
	Laggers	.930	22	.125	
	Leading Innovators	.906	41	.003	
Work Discretion	Followers	.966	81	.031	Kruskal-Wallis
	Inventors	.928	35	.024	
	Laggers	.984	22	.965	
	Leading Innovators	.968	41	.306	
Time Availability	Followers	.959	81	.011	Kruskal-Wallis
	Inventors	.860	35	.000	
	Laggers	.962	22	.529	
	Leading Innovators	.923	41	.008	

Notes: Underlined values indicate statistical significance at α=0.05.

The cluster means, overall and pairwise Kruskal-Wallis one-way mean comparisons for each cluster in terms of the four performance components of organizational culture are tabulated in **Table 6.8**. The findings suggest that there is a statistical significance among clusters in terms of management support and reward system components with *p*-values

p=0.004 and p=0.046 respectively, while there exist no statistical significance among clusters in work discretion and time availability components (p=0.100 and p=0.058). Om a pairwise comparison, a statistical significance was detected between cluster means of Leading Innovators and Laggers in terms of management support component (3.772 and 3.154). These two clusters are distinguishable in terms of their mean scores and are open for interpretation.

Table 6.8. Organizational Culture Mean Comparison Results

Organizational Culture	Leading Innovators (Cluster 1)	Followers (Cluster 2)	Inventors (Cluster 3)	Laggers (Cluster 4)	F (or K)
Management Support					
Cluster Mean	3.772 (4)	3.573	3.377	3.154 (1)	13.335 <u>p<0.004</u>
Reward System					
Cluster Mean	3.946	3.665	3.331	3.450	8.024 <u>p<0.046</u>
Work Discretion					
Cluster Mean	3.468	3.229	3.262	3.000	6.250 p<0.100
Time Availability					
Cluster Mean	3.504	3.069	3.228	2.969	7.473 p<0.058

Notes: Numbers in parantheses indicate the cluster groups from which this cluster is significantly different at α=0.05. Corresponding F and K values are based on ANOVA and Kruskal-Wallis tests. Underlined values indicate statistical significance at α=0.05.

Leading Innovators

The Leading Innovators outclass all the other clusters in all performance components of organizational culture elements by having higher average scores (3.772, 3.946, 3.468, 3.504). This fact suggests that Leading Innovator firms attach significance to encouraging innovative activities by providing individual support, maintaining a sustainable and creative environment, rewarding innovative success with incentives, allocating enough time for employees to develop innovative ideas besides their workload and the authority and responsibility to pursue the ideas that can lead to innovative benefits for the firm. As a result of the pairwise statistical significance investigation, Leading Innovators outperform Laggers in terms of management support component, suggesting that these firms are specifically better at supporting their employees' innovative endeavours compared to Laggers, the cluster that is least innovative in all innovation types by OECD (2005).

Followers

The Followers are behind the Leading Innovators in management support and reward system components, while they are performing slightly worse in work discretion and time availability compared to Inventors. Followers denote more emphasis on supporting the employees' innovative activities and rewarding them highly, in comparison with granting them the work discretion and time required to innovate.

Inventors

Inventors are more successful at providing work discretion and time availability to their employees compared to the Followers. Even though the employees in Inventor firms have less management support and less incentives to innovate, they are product innovators to a great extend as a result of the work discretion and time availability provided to them to innovate. This result suggests that in order to be product innovators, autonomy provision and time allocation to employees should be more important for firms than the management support or the highly rewarding incentive schemes.

Laggers

As expected, Laggers have the lowest scores in all components of organizational culture, except the reward system (3.450). Similar to their name suggests, these firms lag behind all other clusters, but are slightly better at incentivizing the innovative activities compared to the inventors. Laggers also exhibit statistical significance in terms of its mean value compared with the Leading Innovators for management support component (3.772 and 3.154). Employees in Lagger firms are extremely deprived of management support they need to engage in innovative activities.

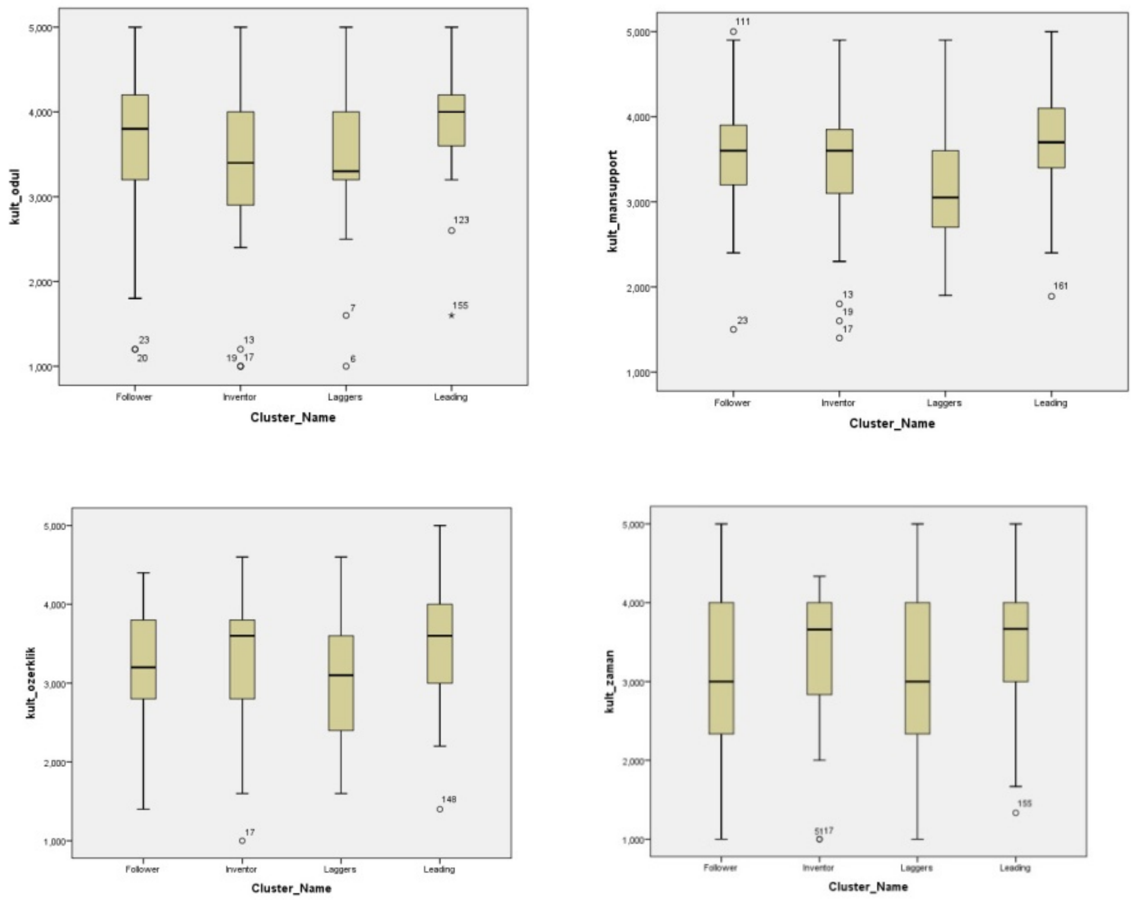


Figure 6.9. Box-plots of Organizational Culture

Figure 6.9 presents the box-plots of the organizational culture performance factors categorized in accordance with the innovation clusters. The vertical axes denote the organizational culture performance factors that are management support, reward system, work discretion and time availability, whereas the horizontal axes denote the cluster groups formed through cluster analysis.

6.2.5 Barriers to Innovation

Table 6.9 summarizes the *p*-values for normality tests conducted on Barriers to Innovation driver. As a result of the higher *p*-values, Internal Resistance, Internal Deficiencies, External Difficulties and External Limitations components were detected to have non-normal distribution and non-parametric one-way Kruskal-Wallis tests were applied for mean comparisons. Surprisingly, depending on the relatively lower p-values in Internal Limitations component, its distribution was revealed to be normally distributed. For this reason, parametric one-way mean comparison ANOVA test was conducted on this component.

The cluster means of each resulting cluster in terms of the five performance components of barriers to innovation are tabulated in **Table 6.10**, both overall and pairwise. Statistical significance exists in internal deficiencies and internal lcomponents with *p*-values $p=0.020$ and $p=0.015$ respectively. There is no statistical significance detected in internal resistance, external difficulties and external limitations as a result of the non-parametric Kruskal-Wallis test with values $p=0.099$, $p=0.196$ and $p=0.210$ respectively at this confidence interval. When investigated pairwise, Followers and Inventors statistically differ in their means in terms of internal deficiencies component., whereas Leading Innovators and Inventors significantly differ in internal limitations.

Table 6.9. Barriers to Innovation Normality Test Results

Component	Cluster	Shapiro-Wilk			TEST
		Statistic	df	Significance	
Internal Resistance	Followers	.978	82	.166	Kruskal-Wallis
	Inventors	.945	34	.090	
	Laggers	.979	21	.915	
	Leading Innovators	.923	40	.010	
Internal Deficiencies	Followers	.982	82	.306	Kruskal-Wallis
	Inventors	.971	34	.485	
	Laggers	.904	21	.042	
	Leading Innovators	.975	40	.497	
Internal Limitations	Followers	.977	82	.149	ANOVA
	Inventors	.952	34	.138	
	Laggers	.946	21	.287	
	Leading Innovators	.960	40	.164	
External Difficulties	Followers	.957	82	.008	Kruskal-Wallis
	Inventors	.974	34	.568	
	Laggers	.937	21	.190	
	Leading Innovators	.966	40	.258	
External Limitations	Followers	.969	82	.047	Kruskal-Wallis
	Inventors	.956	34	.188	
	Laggers	.990	21	.998	
	Leading Innovators	.957	40	.130	

Notes: Underlined values indicate statistical significance at α=0.05.

Table 6.10. Barriers to Innovation Mean Comparison Results

Barriers to Innovation	Leading Innovators (Cluster 1)	Followers (Cluster 2)	Inventors (Cluster 3)	Laggers (Cluster 4)	F (or K)
Internal Resistance					
Cluster Mean	3.802	3.714	3.500	3.375	6.269 $p<0.099$
Internal Deficiencies					
Cluster Mean	3.358	3.339 (3)	2.742 (2)	3.370	9.831 <u>$p<0.020$</u>
Internal Limitations					
Cluster Mean	3.486 (3)	3.214	2.870 (1)	3.028	3.580 <u>$p<0.015$</u>
External Difficulties					
Cluster Mean	3.612	3.851	3.507	3.818	4.692 $p<0.196$
External Limitations					
Cluster Mean	3.445	3.454	3.073	3.215	4.525 $p<0.210$

Notes: Numbers in parantheses indicate the cluster groups from which this cluster is significantly different at $\alpha=0.05$. Corresponding F and K values are based on ANOVA and Kruskal-Wallis tests. Underlined values indicate statistical significance at $\alpha=0.05$.

Leading Innovators

Leading Innovators score highest on internal resistance and internal limitations. Leading innovators suffer greatly from internal resistance and internal limitations and can not achieve innovative success, as they perceive. The corporate climate is not suitable, missions and values are fuzzy and unclear to the employees. As internal limitations, there are time restrictions, the routinized workload and and insufficient auditing are reasons firms in Leading Innovators believe to constitute major barriers.

Followers

Followers catch up with the perception of barrier components with the Leading Innovators, as they exhibit similar mean scores.

Inventors

Inventors consider the internal deficiencies to be the least of their problems among all components of barriers to innovation (2.742). This average score seems to be relatively smaller compared to those of other clusters. We can deduce that these firms believe they lack the technical experience, the know-how and qualified stuff to generate or realize innovative ideas.-

Laggers

Laggers score only the lowest in internal resistance (3.375). These firms believe that their bottleneck is the lack of a corporate climate encouraging to think innovatively and the corporate objectives are not consistent with generation of new ideas.

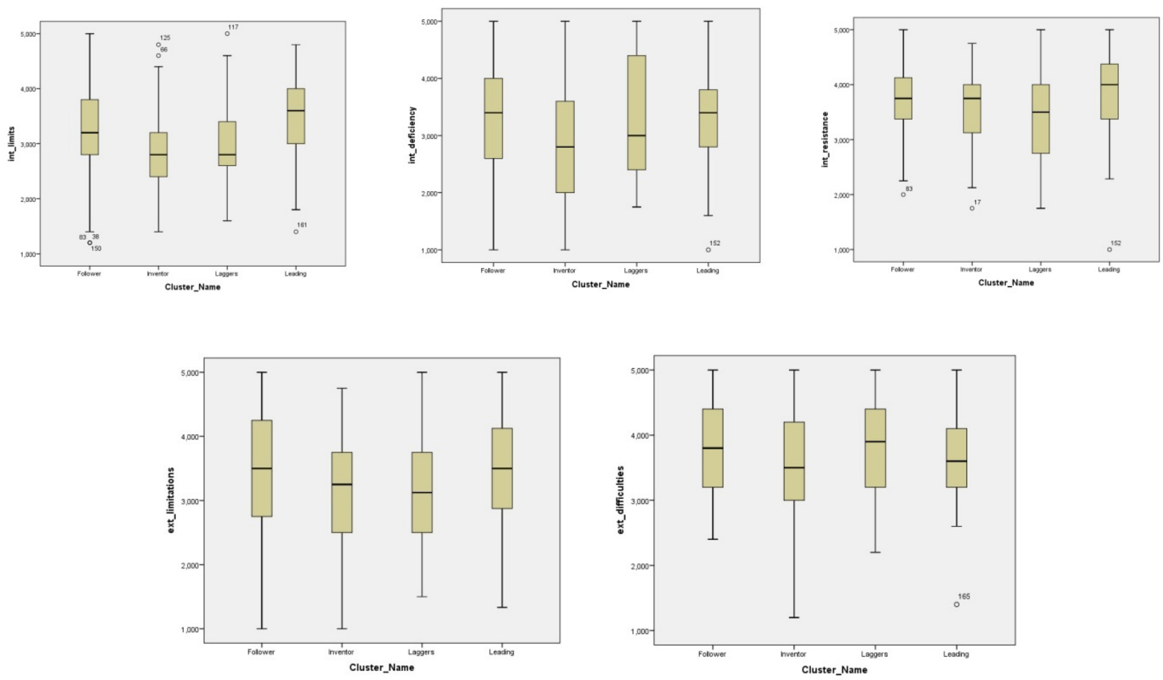


Figure 6.10. Box-plots of Barriers to Innovation

Figure 6.10 presents the box-plots of the barriers to innovation performance components categorized in accordance with the innovation clusters. The vertical axes denote the barriers to innovation performance factors that are internal resistance, internal deficiencies, internal limitations, external difficulties and external limitations, whereas the horizontal axes denote the cluster groups formed through cluster analysis.

6.2.6 Monitoring

Table 6.11 summarizes the p-values for normality tests conducted on Monitoring innovation driver. As a result of the higher *p*-value, Monitoring Inner Milieu factor was comprehended to have normal distribution and parametric one-way ANOVA test was applied for mean comparisons. Relatively lower *p*-values in monitoring outer milieu and monitoring open innovation resources factors, revealed their distribution to be non-normal. For this reason, non-parametric mean comparison test Kruskal-Wallis was conducted on this factor.

Table 6.11. Monitoring Normality Test Results

Component	Cluster	Shapiro-Wilk			TEST
		Statistic	df	Significance	
Monitoring Outer Milieu	Followers	.924	82	<u>.000</u>	Kruskal-Wallis
	Inventors	.865	34	<u>.001</u>	
	Laggers	.752	21	<u>.000</u>	
	Leading Innovators	.948	40	.063	
Monitoring Inner Milieu	Followers	.981	82	.270	ANOVA
	Inventors	.992	34	.995	
	Laggers	.913	21	.062	
	Leading Innovators	.963	40	.210	
Monitoring Open Innovation Resources	Followers	.970	82	.055	Kruskal-Wallis
	Inventors	.949	34	.115	
	Laggers	.960	21	.519	
	Leading Innovators	.936	40	<u>.026</u>	

Notes: Underlined values indicate statistical significance at α=0.05.

The cluster means of each resulting category in terms of the three performance factors of monitoring are tabulated in **Table 6.12** There exists a statistical significance among cluster means in monitoring outer milieu and monitoring inner milieu, with *p*-values *p*=0.000 and *p*=0.000 respectively. On a pairwise comparison, Leading Innovators are statistically different from Inventors and Laggers in these two components. No statistical significance, both overall and pairwise, was found for monitoring open innovation resources.

Table 6.12. Monitoring Mean Comparison Results

Monitoring	Leading Innovators (Cluster 1)	Followers (Cluster 2)	Inventors (Cluster 3)	Laggers (Cluster 4)	F (or K)
Monitoring Outer Milieu					
Cluster Mean	2.568 (3.4)	2.145	1.720 (1)	1.809 (1)	18.080 <u>p<0.000</u>
Monitoring Inner Milieu					
Cluster Mean	3.590 (3.4)	3.187	2.864 (1)	2.859 (1)	6.14 <u>p<0.000</u>
Monitoring Open Innovation Resources					
Cluster Mean	3.391	3.280	3.078	2.742	7.379 p<0.060

Notes: Numbers in parantheses indicate the cluster groups from which this cluster is significantly different at α=0.05. Corresponding F and K values are based on ANOVA and Kruskal-Wallis tests. Underlined values indicate statistical significance at α=0.05.

Leading Innovators

Leading Innovators outperform all other clusters in all three components (2.568, 3.590 and 3.391). These firms are more active in terms of monitoring inner and outer sources, which contributes greatly to the competitive intelligence of the firms.

Followers

Followers, as expected, rank the second in average scores behind the Leading Innovators. These firms are also successful at constantly monitoring their own supply chain, by continuous interaction with their customers, suppliers and vendors. They also excel at monitoring outer resources and open resources to extract the know-how and keep up-to-date with the recent trends.

Inventors

Inventors are better at monitoring inner milieu and the open innovation resources compared to Laggers, but they are worse at monitoring the outer milieu with a slight difference.

Laggers

Laggers are falling behind in every aspect of monitoring driver of innovativeness, except they are better at monitoring the outer sources compared to their neighboring cluster Inventors.

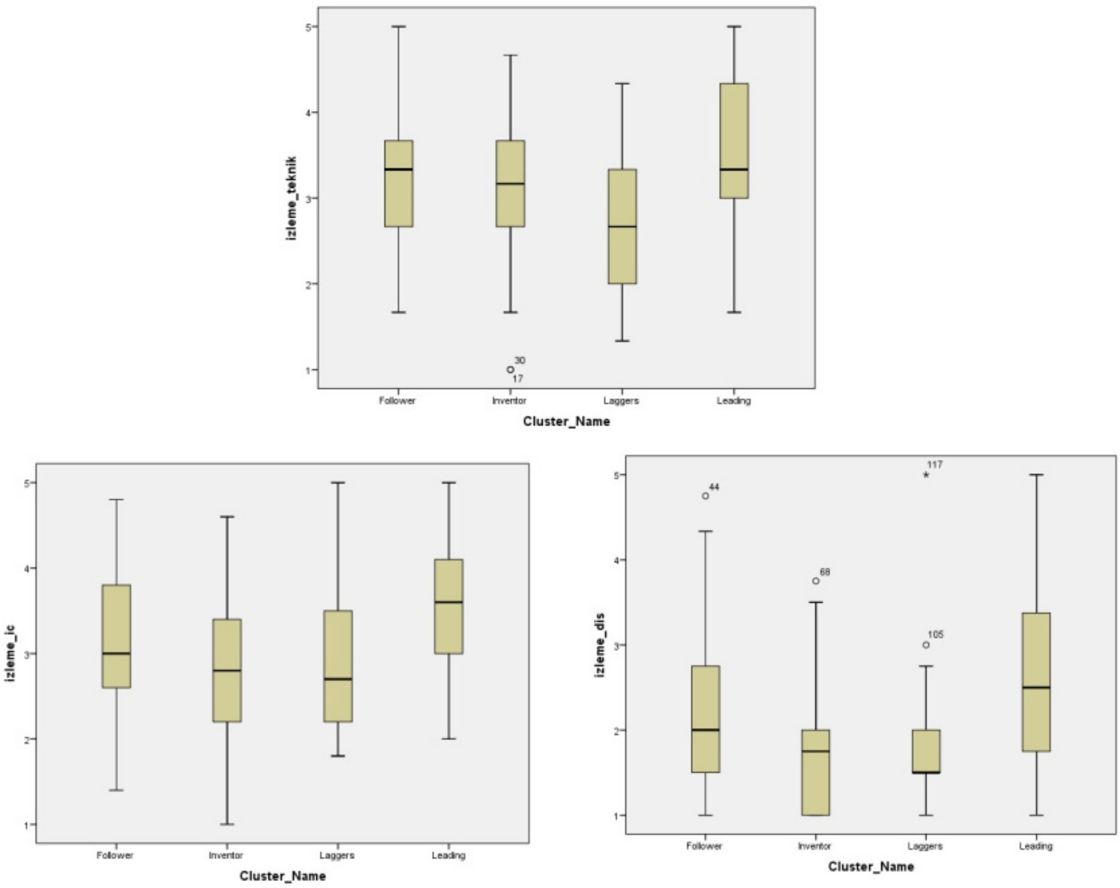


Figure 6.11. Box-plots of Monitoring

Figure 6.11 presents the box-plots of the monitoring performance factors categorized in accordance with the innovation clusters. The vertical axes denote the monitoring performance factors that are monitoring outer mileu, monitoring inner mileu and monitoring open innovation resources, whereas the horizontal axes denote the cluster groups formed through cluster analysis.

6.2.7 Collaborations

R&D Collaborations involve cooperation of firms with the third party research centers and universities, as well as its rivals and firms from other industries. Vertical Collaborations necessitate working hand in hand with the suppliers and the customers in order to strengthen the supply chain by having an overall view and obtain innovative ideas. Lastly, operational cullaborations require teamwork in vital operations in terms of production, purchasing, service/delivery/sales, staff education and staying ahead of competition.

Table 6.13. Collaborations Normality Test Results

Component	Cluster	Shapiro-Wilk			TEST
		Statistic	df	Significance	
R&D Collaborations	Followers	.713	82	.000	Kruskal-Wallis
	Inventors	.797	35	.000	
	Laggers	.596	22	.000	
	Leading Innovators	.788	41	.000	
Vertical Collaborations	Followers	.711	82	.000	Kruskal-Wallis
	Inventors	.768	35	.000	
	Laggers	.695	22	.000	
	Leading Innovators	.635	41	.000	
Operational Collaborations	Followers	.904	82	.000	Kruskal-Wallis
	Inventors	.876	35	.001	
	Laggers	.882	22	.013	
	Leading Innovators	.902	41	.002	

Notes: Underlined values indicate statistical significance at α=0.05.

Table 6.13 summarizes the p-values for normality tests conducted on Collaborations innovation driver. As a result of the lower p-values, all collaboration factors were perceived to be non-normally distributed and follow a non-parametric distribution scheme. For this reason, Kruskal-Wallis non-parametric mean comparison tests were conducted on these factors for overall mean comparison and pairwise multiple mean comparisons.

The cluster means of each resulting category in terms of the three performance components of collaborations are tabulated in **Table 6.14**, both overall and pairwise. It is worth remarking that out of six drivers of innovativeness, collaboration averages are the lowest, which suggests that collaborative activities of the firms in our database are neglected to a great extend.

Table 6.14. Collaborations Mean Comparison Results

Collaboration	**Leading Innovators (Cluster 1)**	**Followers (Cluster 2)**	**Inventors (Cluster 3)**	**Laggers (Cluster 4)**	**F (or K)**
R&D Collaboration					
Cluster Mean	1.235	1.170	1.247	1.136	5.180 p<0.159
Vertical Collaboration					
Cluster Mean	1.768	1.682	1.600	1.500	6.445 p<0.092
Operational Collaboration					
Cluster Mean	1.370	1.346	1.328	1.263	2.066 p<0.559

Notes: Numbers in parantheses indicate the cluster groups from which this cluster is significantly different at α=0.05. Corresponding F and K values are based on ANOVA and Kruskal-Wallis tests. Underlined values indicate statistical significance at α=0.05.

There exists no statistical significance among means of the clusters, evaluated both overall and pairwise. This finding and the fact that the lowest mean scores among all six drivers of innovativeness belong to components of collaborations, suggests that the emphasis placed on collaborations are the least in all industries across all firms. The importance three components of collaborations are not understood in Turkey, and collaborative activities are not finding room in innovative activities of Turkish manufacturing firms.

Leading Innovators

Leading Innovators rank second in R&D Collaborations after Inventors. These firms take the lead in Vertical and Operational Collaborations and perform slightly better.

Followers

Followers rank second after Leading Innovators in terms of their average scores, except the R&D Collaboration, the component in which they rank the third.

Inventors

Inventors have the best R&D Collaboration average among all clusters. Inventor firms are successful in product innovation, therefore this result is not surprising. Inventors are engaged more actively in R&D activities in order to innovate succesful products.

Laggers

As expected, Laggers have the lowest mean scores, suggesting that they are behind the competition in terms of collaborative activities.

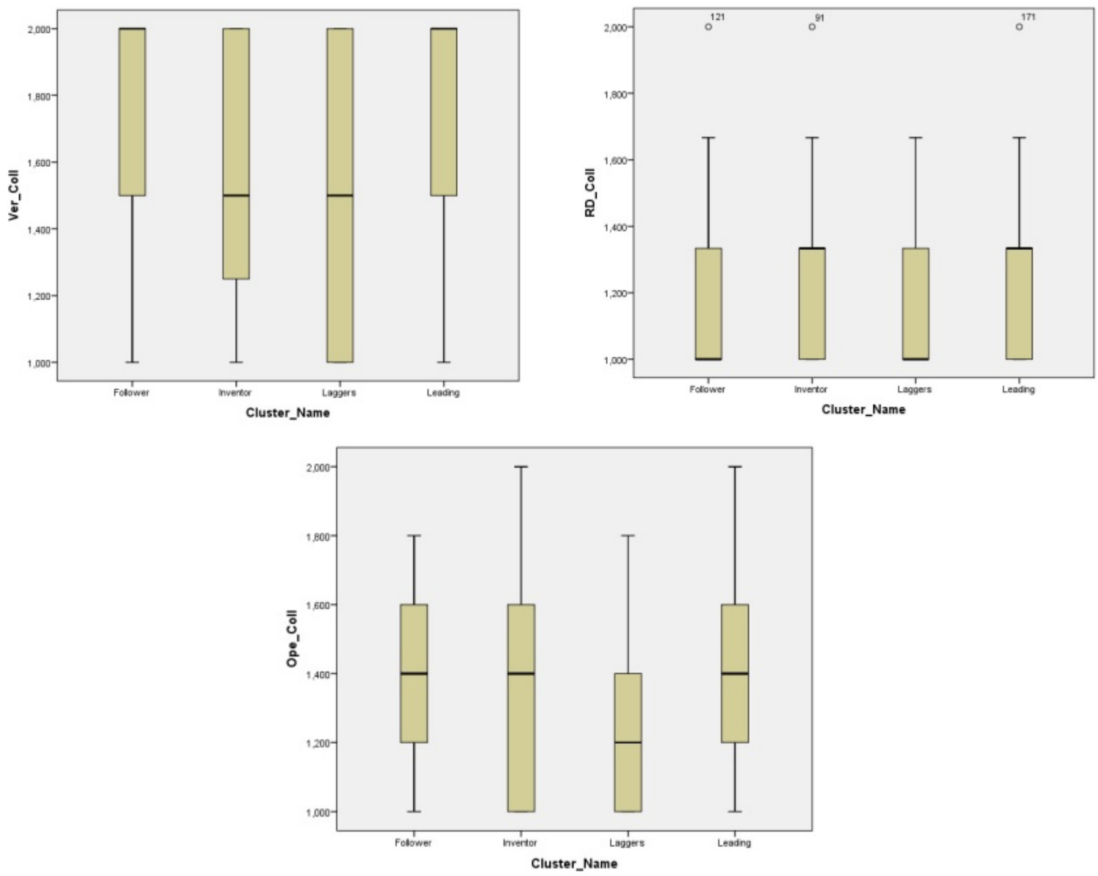


Figure 6.12. Box-plots of Collaborations

Figure 6.12 presents the box-plots of the collaborations performance factors categorized in accordance with the innovation clusters. The vertical axes denote the collaborations performance factors that are R&D collaboration, vertical collaboration and operational collaboration, whereas the horizontal axes denote the cluster groups formed through cluster analysis.

6.2.8 Results Related to Intellectual Capital Ignoring Specialization

Table 6.15 provides the new *p*-values for normality results while **Table 6.16** provides the pairwise and overall mean comparison scores... It is noted that on a pairwise comparison, the findings remain the same. **Table 6.3** reduces to the first three rows, deleting the Specialization row.

Table 6.15. Intellectual capital ignoring Specialization Normality Results

Driver	Cluster	Shapiro-Wilk			TEST
		Statistic	df	Significance	
Intellectual Capital	Followers	.965	82	.169	ANOVA
	Inventors	.956	35	.141	
	Laggers	.925	22	.493	
	Leading Innovators	.986	41	.572	

Table 6.16. Intellectual capital ignoring Specialization Mean Comparison Results

Innovation Driver	Leading Innovators (Cluster 1)	Followers (Cluster 2)	Inventors (Cluster 3)	Laggers (Cluster 4)	F (or K)
Intellectual Capital					
Cluster Mean	3.868 (2,3,4)	3.436 (1)	3.260 (1)	3.291 (1)	15.407 $p<0.000$

6.3 Data Envelopment Analysis

The DEA analysis provided efficiency scores for each firm in our dataset consisting of 184 Turkish manufacturing firms. In order to observe the nature of relationships among the drivers of innovativeness, an Orange framework was developed and the model can be found in **Figure 6.13** below. The figure consists of drivers of innovativeness, performance measures, as well as other visualizations and calculations including correlation analysis and attribute statistics.

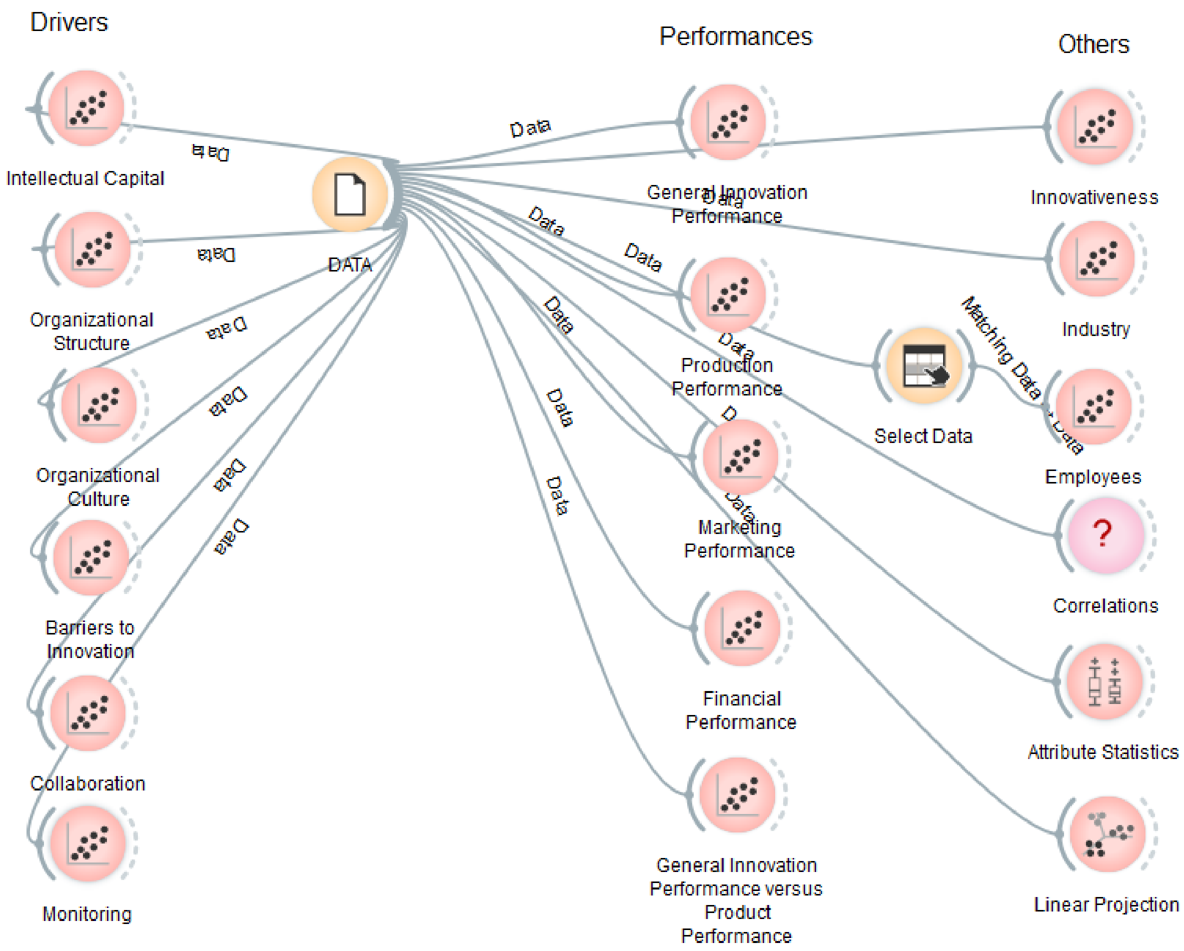


Figure 6.13 Orange Visualization Model

DEA Visualizations are provided in Chapters 6.3.1 and 6.3.2 for the drivers of innovativeness and performance measures respectively. Commentations and observations are made cluster-wise. An investigation on industrial terms failed to yield results and insights.

A Spearman correlation analysis was performed. The results containing rho values for the drivers of innovativeness are displayed in **Figure 6.14,** while the correlation results for the performance measures are displayed in **Figure 6.15.**

	Intellectual Capital	Organizational Structure	Organizational Culture	Barriers to Innovation	Monitoring	Collaborations
Intellectual Capital		0.3384	0.4545	-0.3789	0.4282	0.1547
Organizational Structure	0.3384		0.1811	-0.2189	0.1157	0.0764
Organizational Culture	0.4545	0.1811		-0.2912	0.4264	0.2178
Barriers to Innovation	-0.3789	-0.2189	-0.2912		-0.2136	-0.0594
Monitoring	0.4282	0.1157	0.4264	-0.2136		0.3528
Collaborations	0.1547	0.0764	0.2178	-0.0594	0.3528	

Figure 6.14. Drivers of Innovativeness Correlation Results

	General Performance	Financial Performance	Marketing Performance	Production Performance	Innovative Performance	Innovativeness
General Performance		0.4331	0.8819	0.7308	0.7796	0.2477
Financial Performance	0.4331		0.4689	0.3455	0.2761	0.1103
Marketing Performance	0.8819	0.4689		0.5425	0.5403	0.1205
Production Performance	0.7308	0.3455	0.5425		0.3983	0.2067
Innovative Performance	0.7796	0.2761	0.5403	0.3983		0.3197
Innovativeness	0.2477	0.1103	0.1205	0.2067	0.3197	

Figure 6.15. Performance Measures Correlation Results

In order to explore the statistical significance between cluster variances in terms of their DEA efficiency scores, a normality test was conducted. The results can be found in **Figure 6.16**.

Tests of Normality

	Cluster	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Efficiency	Follower	,088	82	,172	,963	82	,018
	Inventor	,133	34	,137	,953	34	,155
	Laggers	,165	22	,122	,845	22	,003
	Leading	,246	41	,000	,811	41	,000

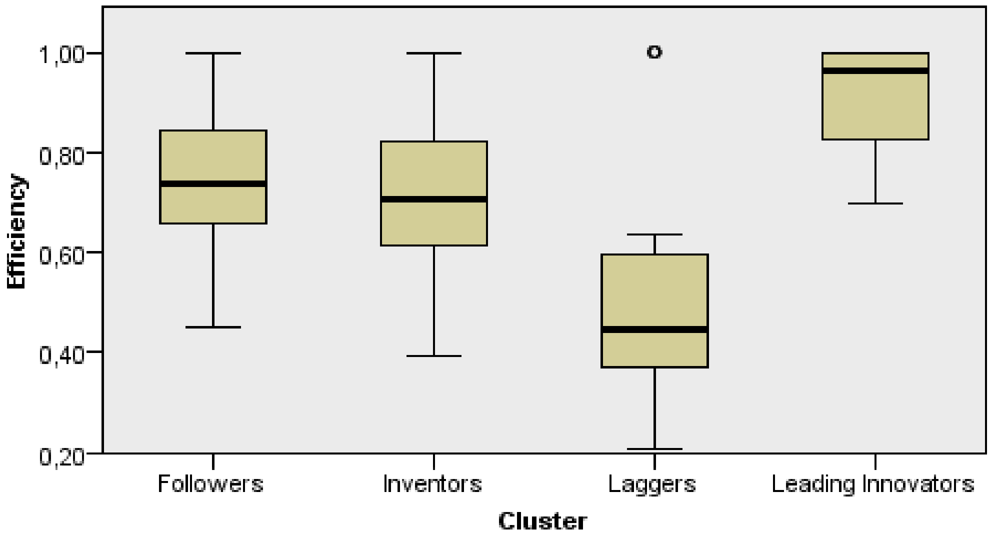
a. Lilliefors Significance Correction

Figure 6.16.Efficiency Scores Normality Results

The normality test revealed that the efficiency scores dataset is not normally distributed among the clusters (0.018, 0.155, 0.003, 0.000), therefore a Kruskal-Wallis test was applied for mean comparisons.

The mean comparison results can be found in **Figure 6.17**. The null hypothesis that the distribution of efficiency scores is the same across categories of clusters is rejected. There exists a statistical significance among the clusters in terms of efficiency score means with an extremely small *p*-value of *p*=0.000.

Independent-Samples Kruskal-Wallis Test



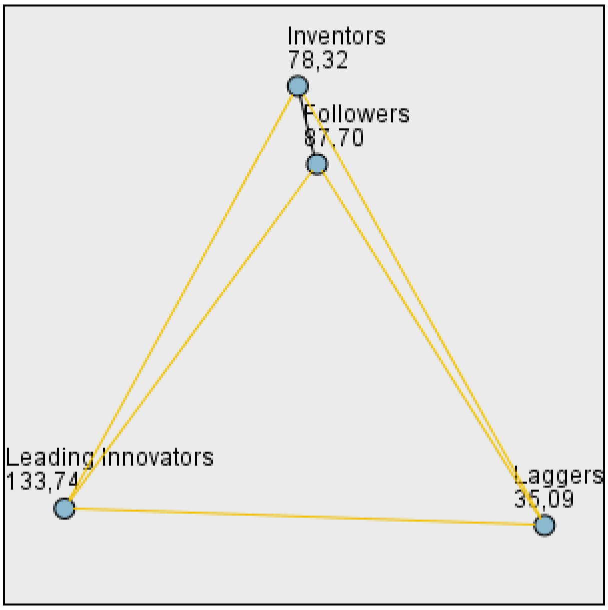
Total N	179
Test Statistic	56,309
Degrees of Freedom	3
Asymptotic Sig. (2-sided test)	,000

1. The test statistic is adjusted for ties.

Figure 6.17 Efficiency Scores Mean Comparison Results

A pairwise Kruskal-wallis mean comparison resulted in **Figure 6.18**. When the results are interpreted pairwise, there exists no statistical difference between inventors and followers.

Pairwise Comparisons of Cluster



Each node shows the sample average rank of Cluster.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Laggers-Inventors	43,233	14,115	3,063	,002	,013
Laggers-Followers	52,610	12,386	4,247	,000	,000
Laggers-Leading Innovators	-98,653	13,634	-7,236	,000	,000
Inventors-Followers	9,378	10,523	,891	,373	1,000
Inventors-Leading Innovators	-55,420	11,966	-4,632	,000	,000
Followers-Leading Innovators	-46,043	9,867	-4,666	,000	,000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is ,05.

Figure 6.18. Pairwise Efficiency Scores Mean Comparison

6.3.1 Drivers of Innovativeness

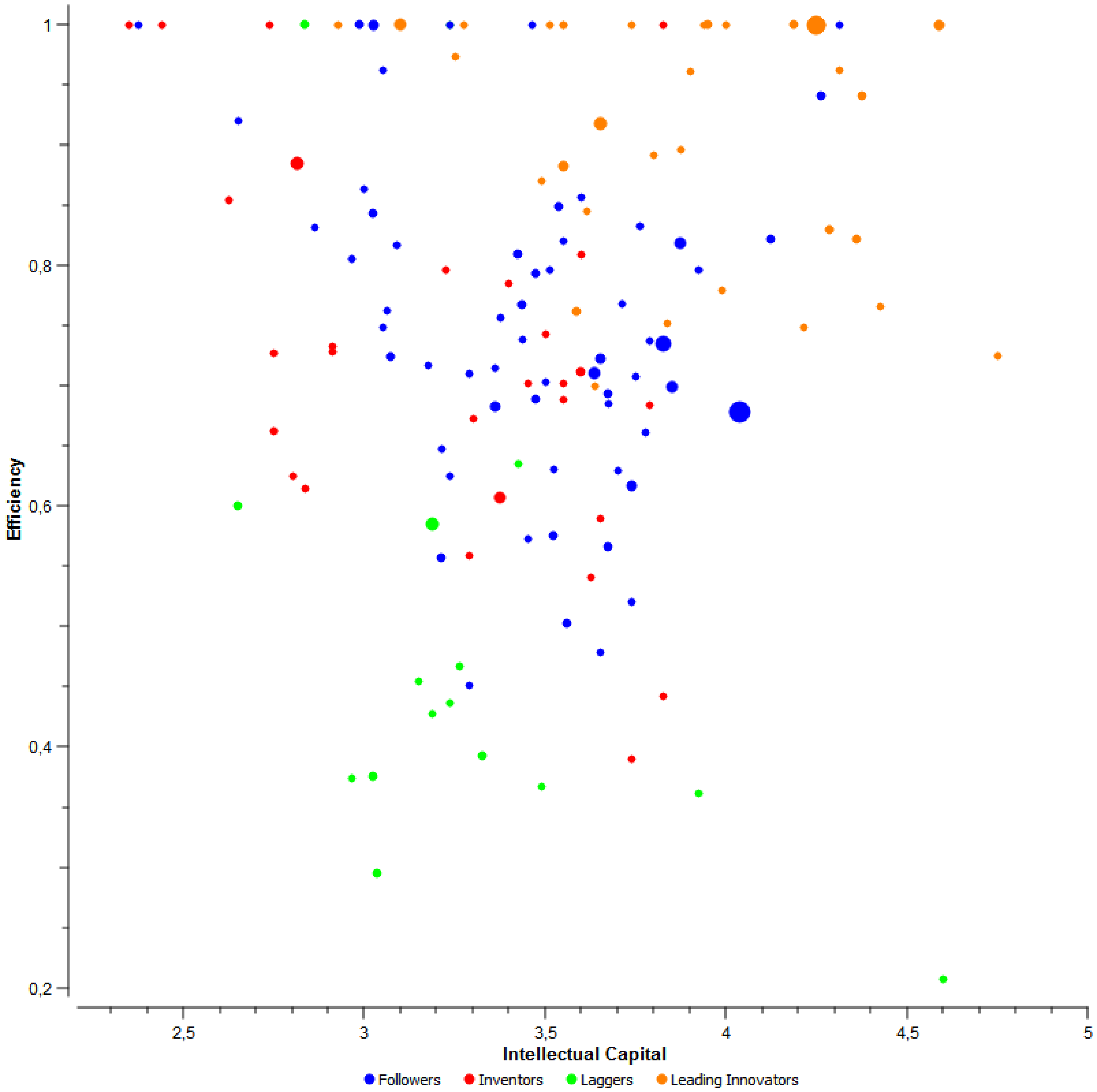


Figure 6. 19 Efficiency versus Intellectual Capital

Figure 6.19 displays the figure comprising efficiency scores and intellectual capital values. The DMU colors denote the clusters, whereas the size of each data point denotes the number of employees. It is observed that the clusters have a descending order, in which Laggers are positioned on the lower half of the figure, Inventors and Followers are situated in the middle, and the Leading Innovators are on the higher end of the spectrum as expected.

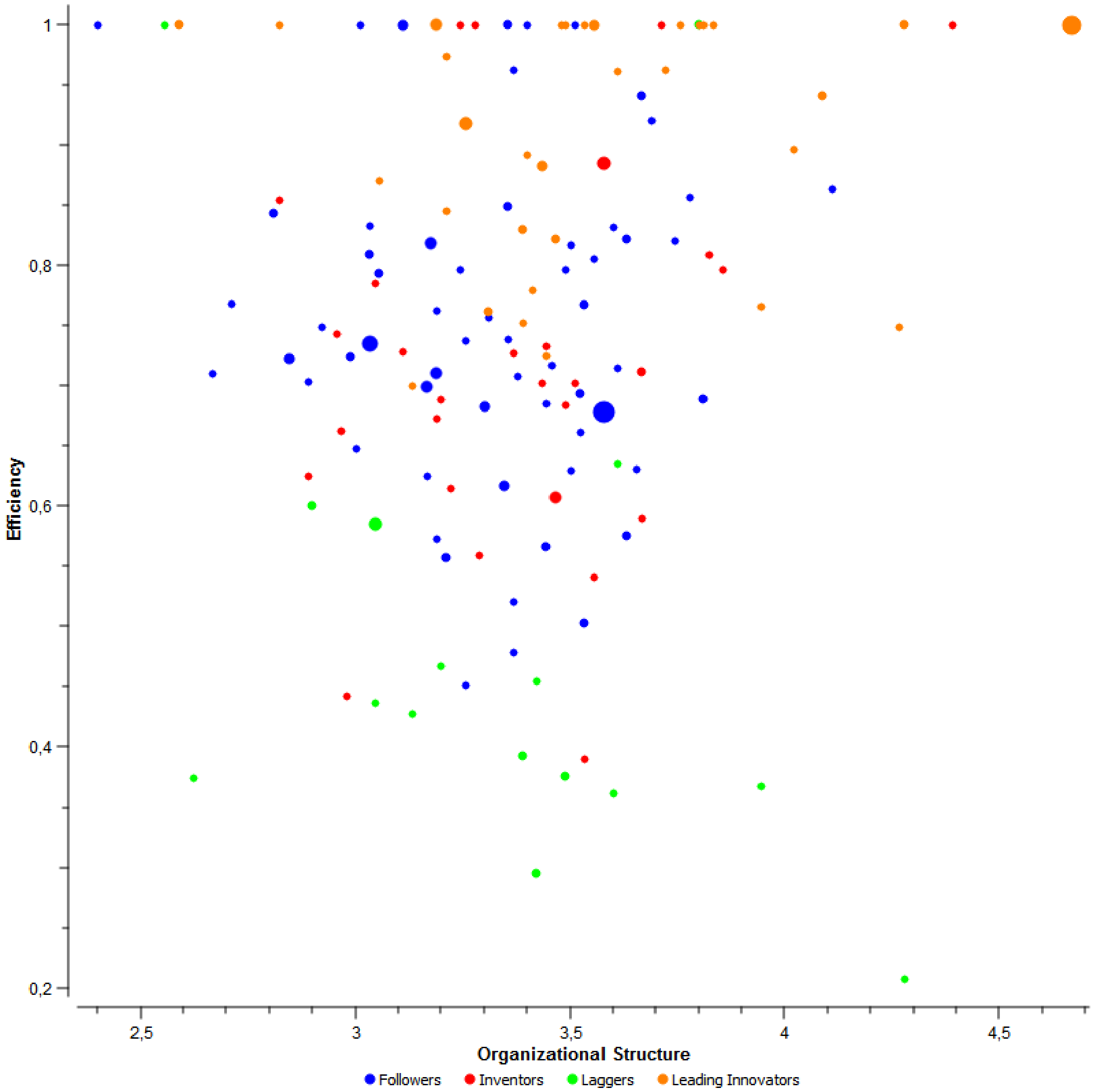


Figure 6.20 Efficiency vs. Organizational Structure

In **Figure 6.20**, we observe similar findings as we have previously for the intellectual capital. The value of efficiency score increases with increasing level in the organizational structure. A similar observation made for **Figure 6.19** is also valid for this figure. Laggers in green color are positioned on the bottom layer of the figure, while Followers and Inventors are positioned in the middle of the figure and the leading innovators in are located on the top.

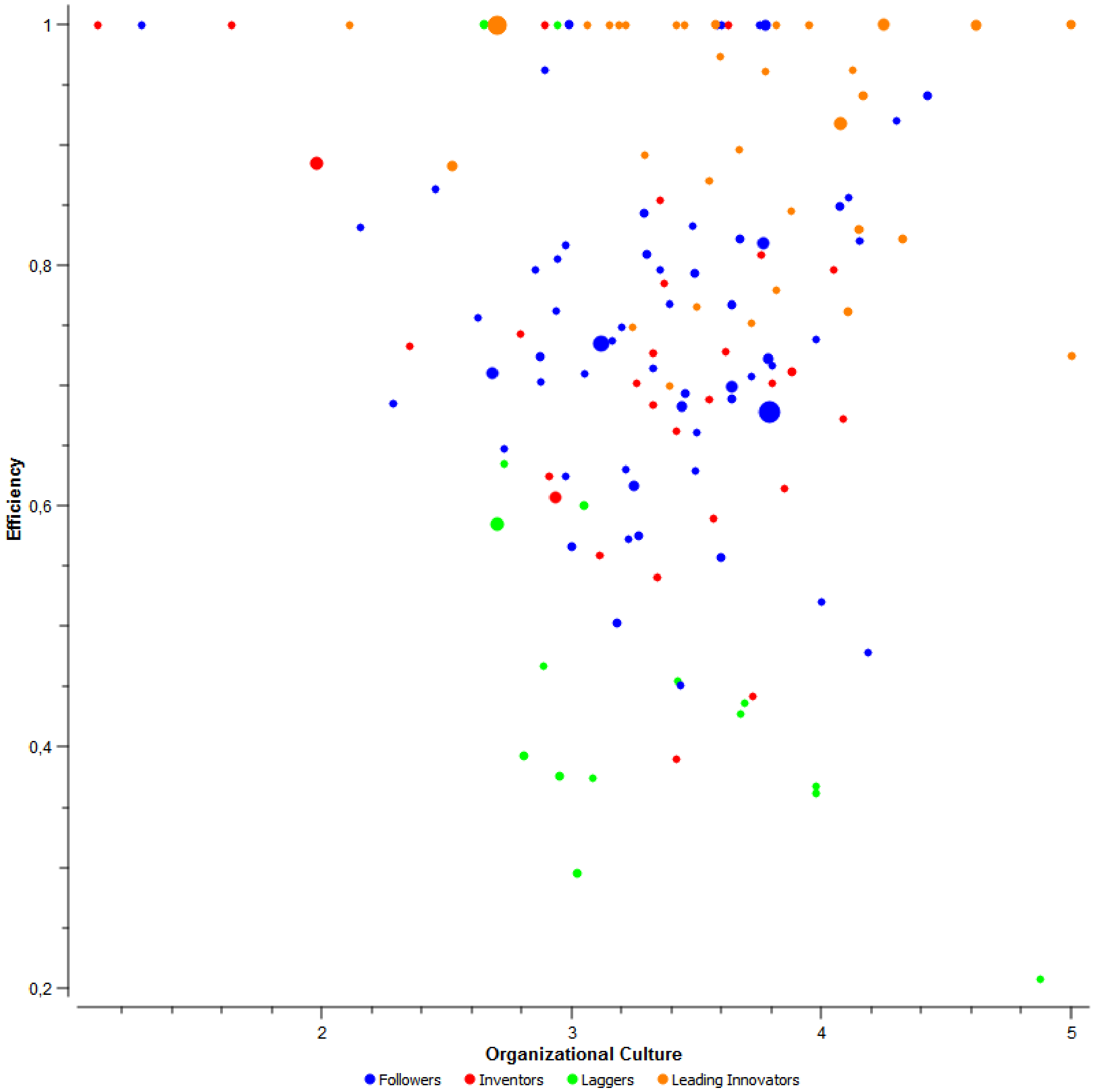


Figure 6.21. Efficiency vs. Organizational Culture

Figure 6.21 displays the figure comprising efficiency scores and organizational culture values.

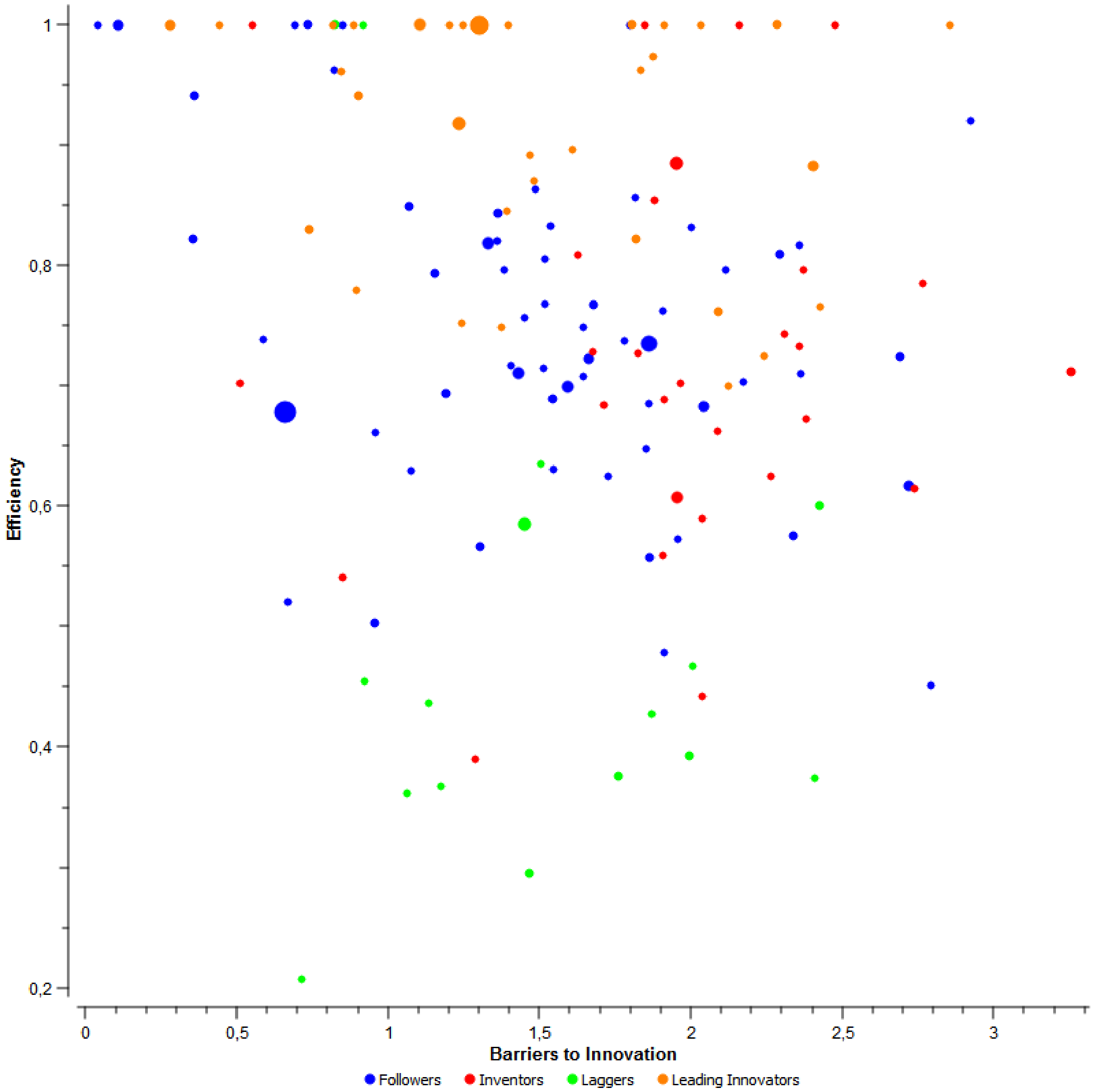


Figure 6.22. Efficiency vs. Barriers to Innovation

Figure 6.22 displays the figure comprising efficiency scores and barriers to innovation values. It is observed that barriers to innovation values do not have an effect on the efficiency scores. Highly efficient firms with efficiency scores of 1 can take lower barriers to innovation scores, as well as higher scores.

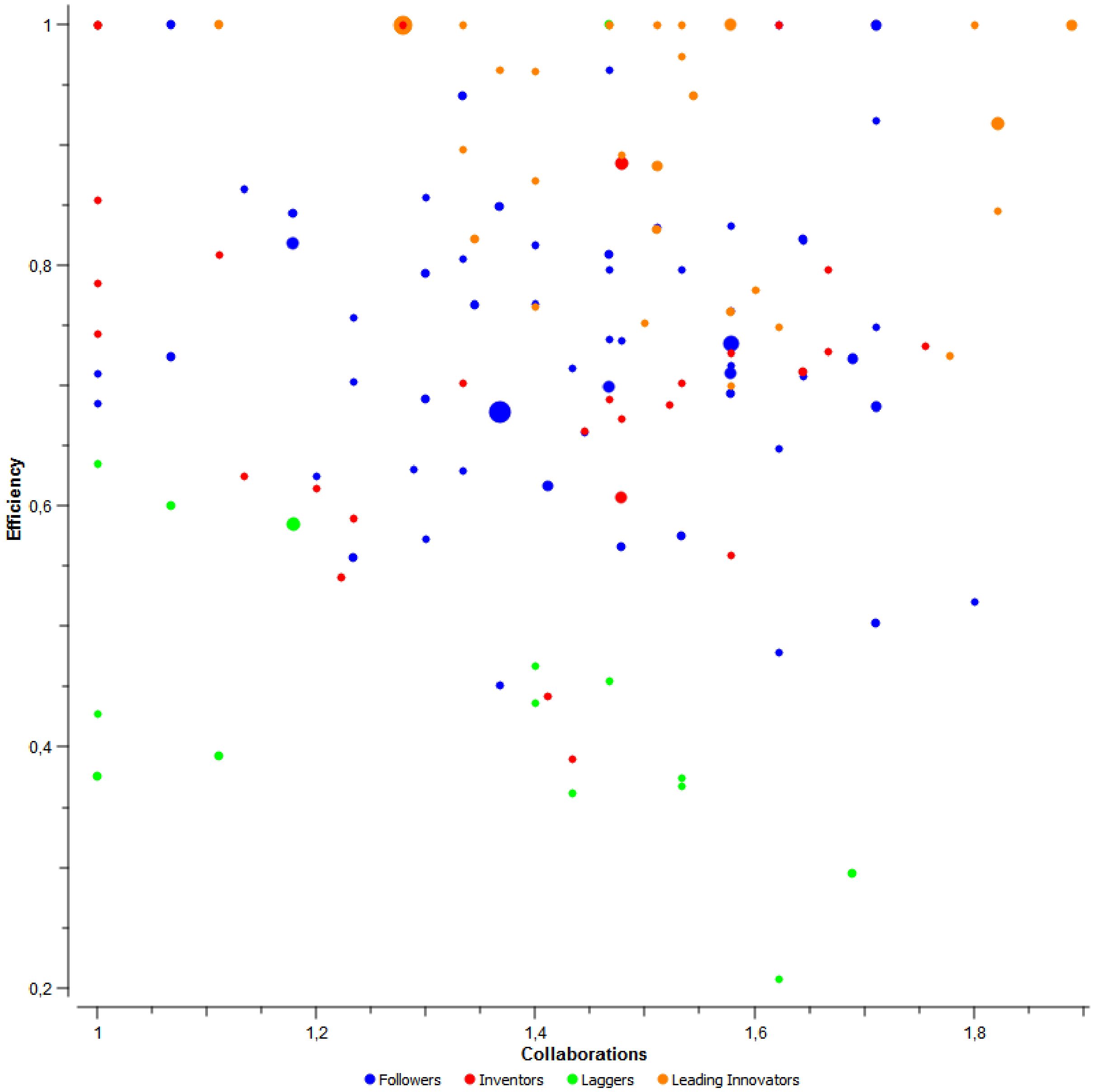


Figure 6.23. Efficiency vs. Collaborations

Figure 6.23 displays the DEA results comprising efficiency scores and collaborations values. It is observed that collaboration values do not have an impact on the efficiency scores. Highly efficient firms with efficiency scores of 1 can take low, as well as high collaboration scores. There is a high variance in the range of collaboration values for the most effective firms.

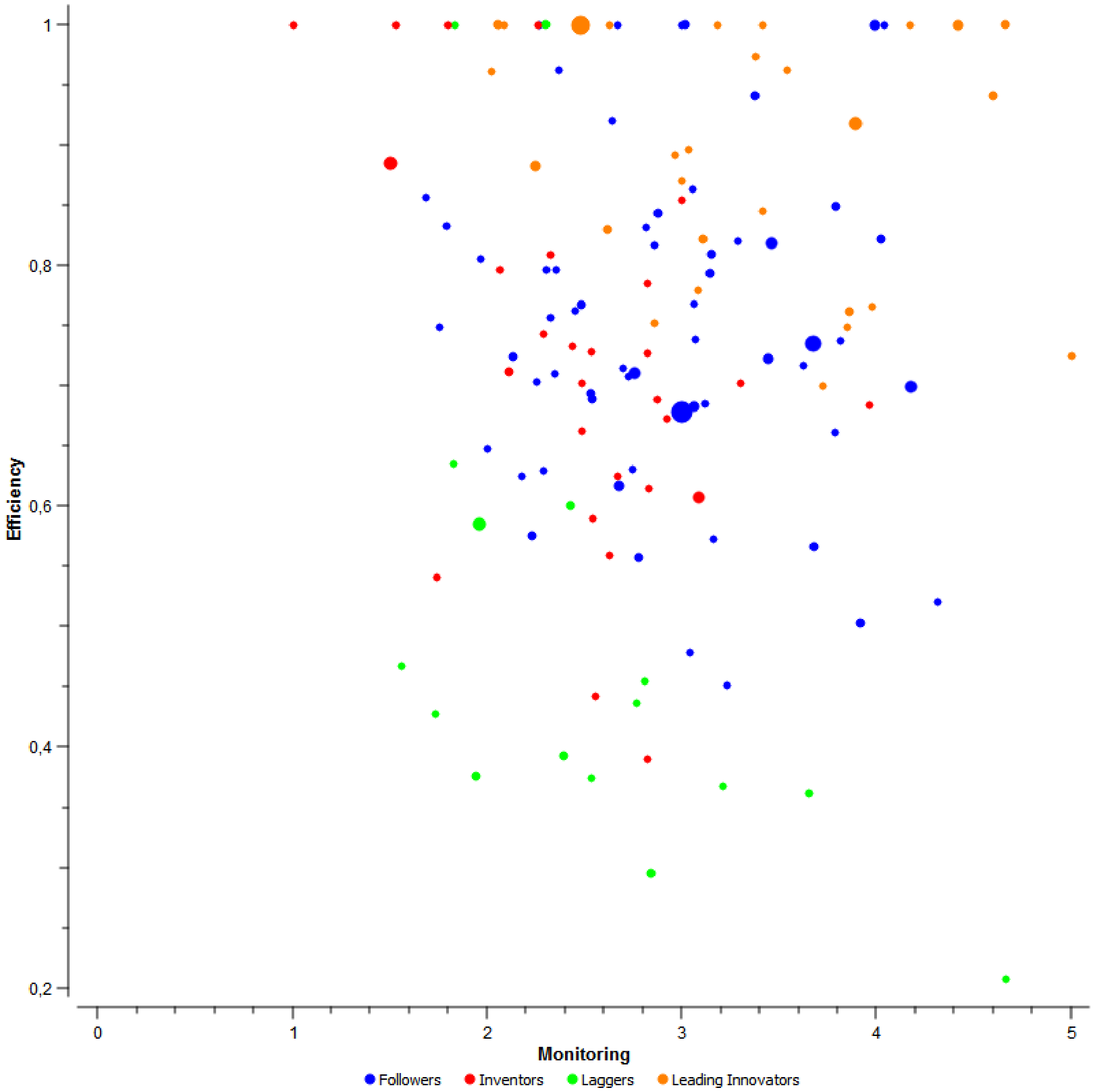


Figure 6.24. Efficiency vs. Monitoring

Figure 6.24 displays the figure comprising efficiency scores and monitoring values. It is observed that collaboration values do not have an impact on the efficiency scores. Highly efficient firms with efficiency scores of 1 can take lower collaboration scores, as well as higher scores. There is a high variance in the range of collaboration values for the most effective firms.

6.3.2 Performance Measures

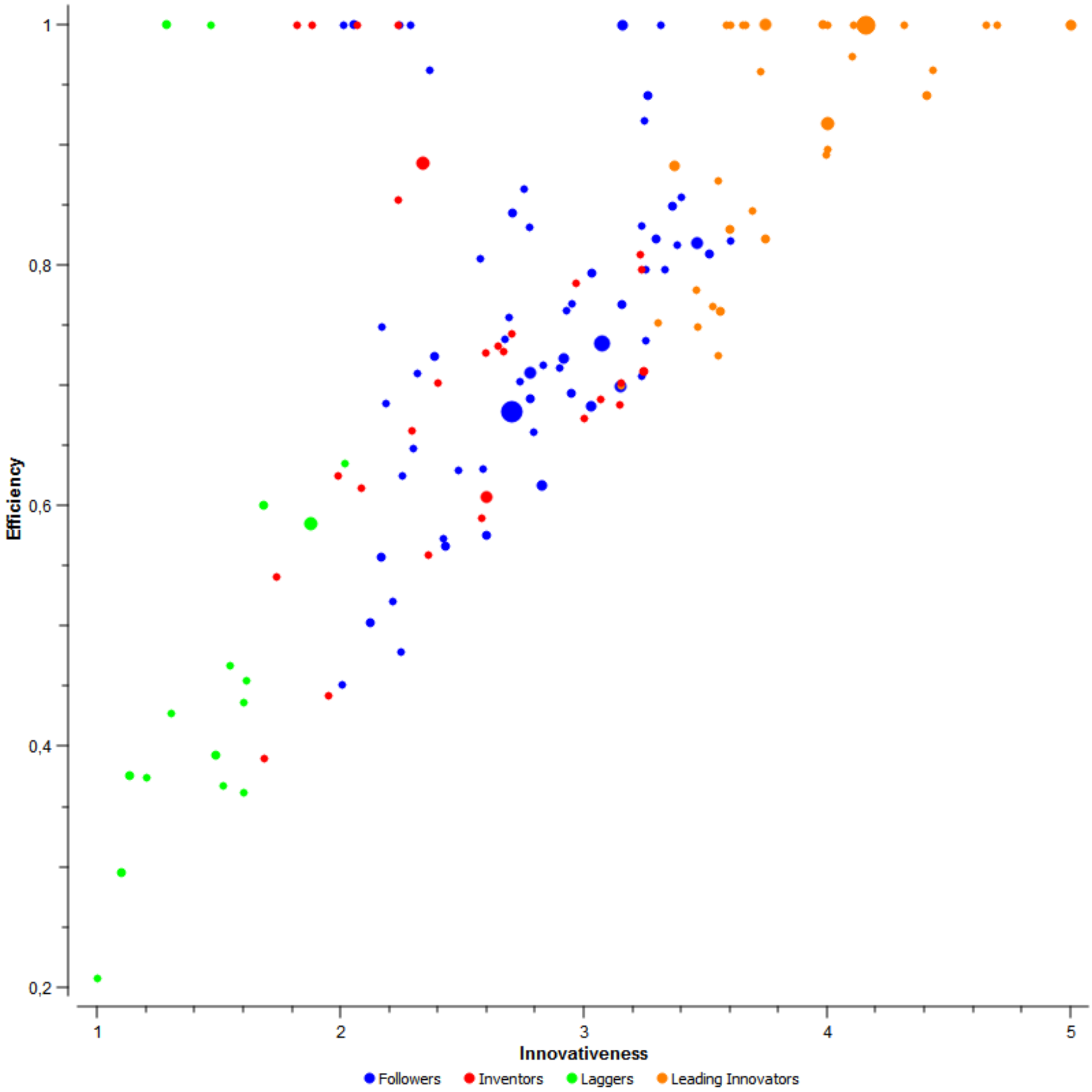


Figure 6.25. Efficiency vs. Innovativeness

Figure 6.25 displays the figure comprising efficiency scores and innovativeness values. It is easily noticable that as innovativeness increases, firms become more efficient. In the light of the graph above, it is only natural to state that firms that invest in innovation and are innovative to a large extend, are successful firms that utilize their resources better and have higher efficiency values. Another natural observation from the figure above is that the clusters obtained from the cluster analyses align and is consistent with a natural grouping of efficiency scores, which suggests that as firms become more innovative, their efficiency scores increase. Firms 28 and 56 in Laggers remain outliers with efficiency scores 1.

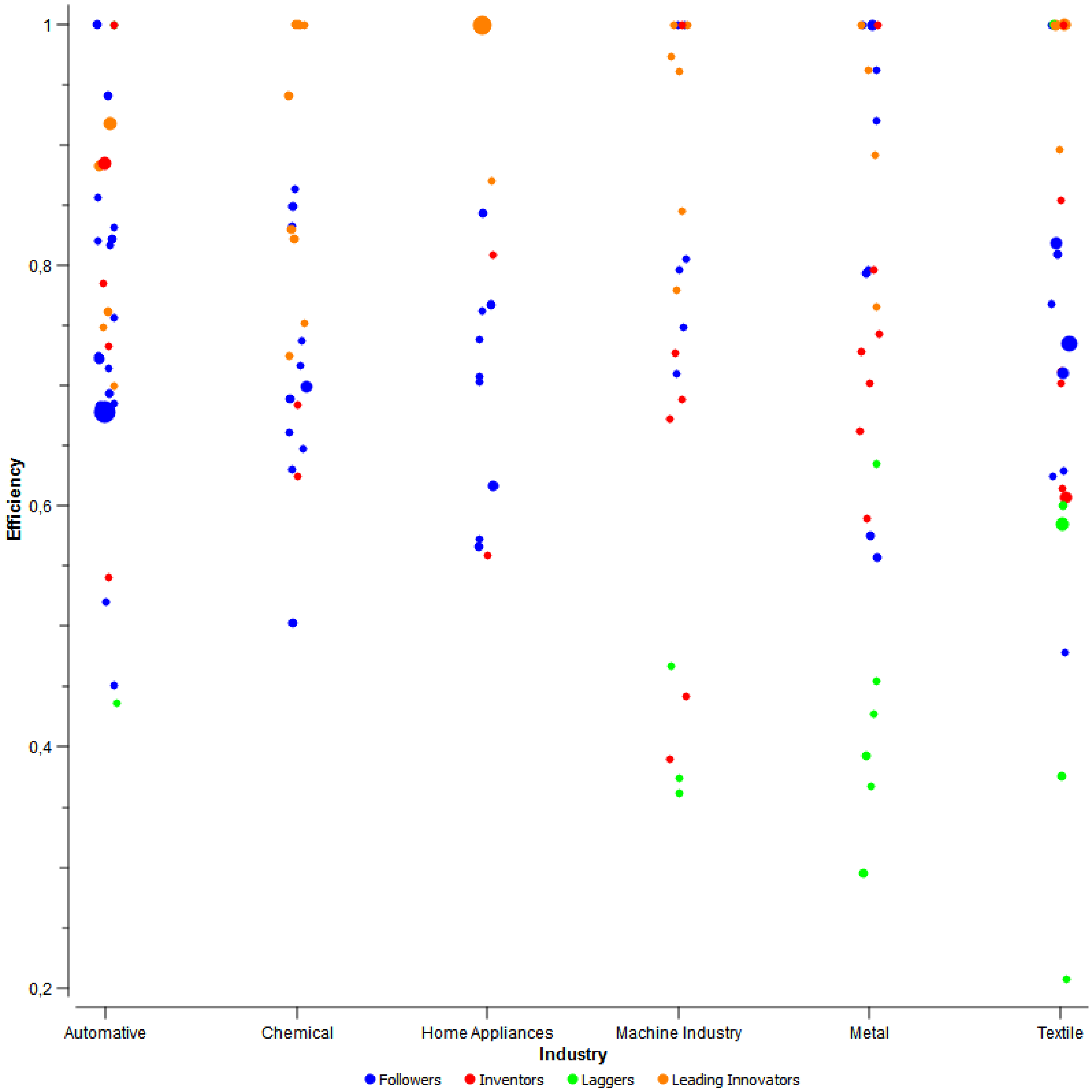


Figure 6.26. Efficiency vs. Industry

Figure 6.26 classifies the firms in terms of their respective industries. Each industry has differences in terms of efficiency scores. The metal industry strikes as the sector that has the highest efficiency range among the firms. In domestic appliances industry, the least efficient firm is more efficient than the minimum efficiency scores of the other industries. There are no laggers in chemical and domestic appliances industries. Once again, the Laggers are positioned on the lower half of the figure, with DEA scores approximately lower than 0.6.

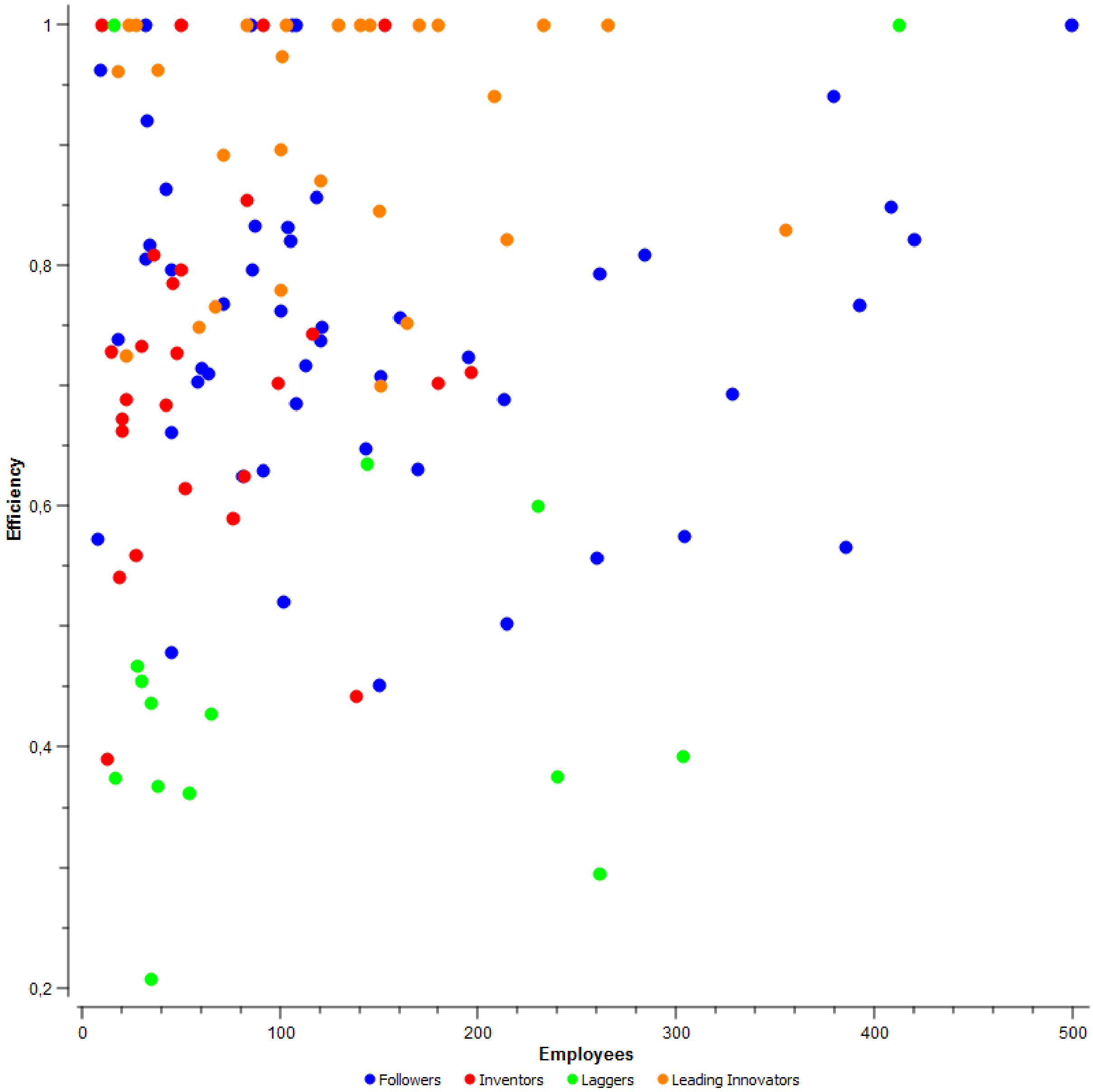


Figure 6.27. Efficiency vs. Number of Employees

Figure 6.27 displays the figure comprising efficiency scores and the number of employees. The DMU colors denote the clusters, and firms with more than 500 employees are considered to be outliers and are excluded from the analysis. It is observed that there is no visible relation between efficiency scores and the number of employees. Fully efficient firms generally have less than 200 employees. It was observed that innovators are generally firms of smaller sizes, categorized as SMEs.

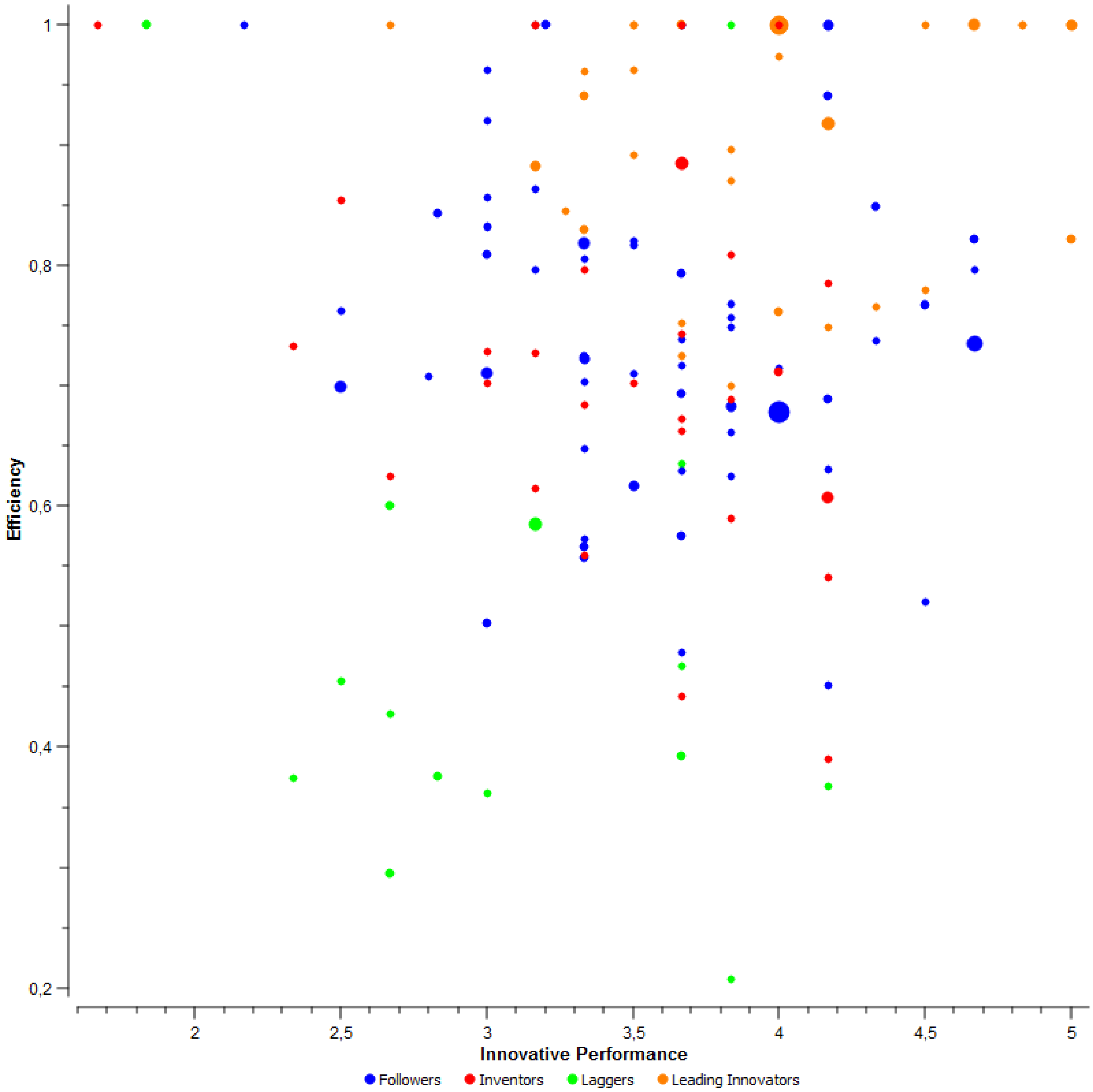


Figure 6.28. Efficiency vs. General Innovation Performance

Figure 6.28 displays the figure comprising efficiency scores and innovative performance values.

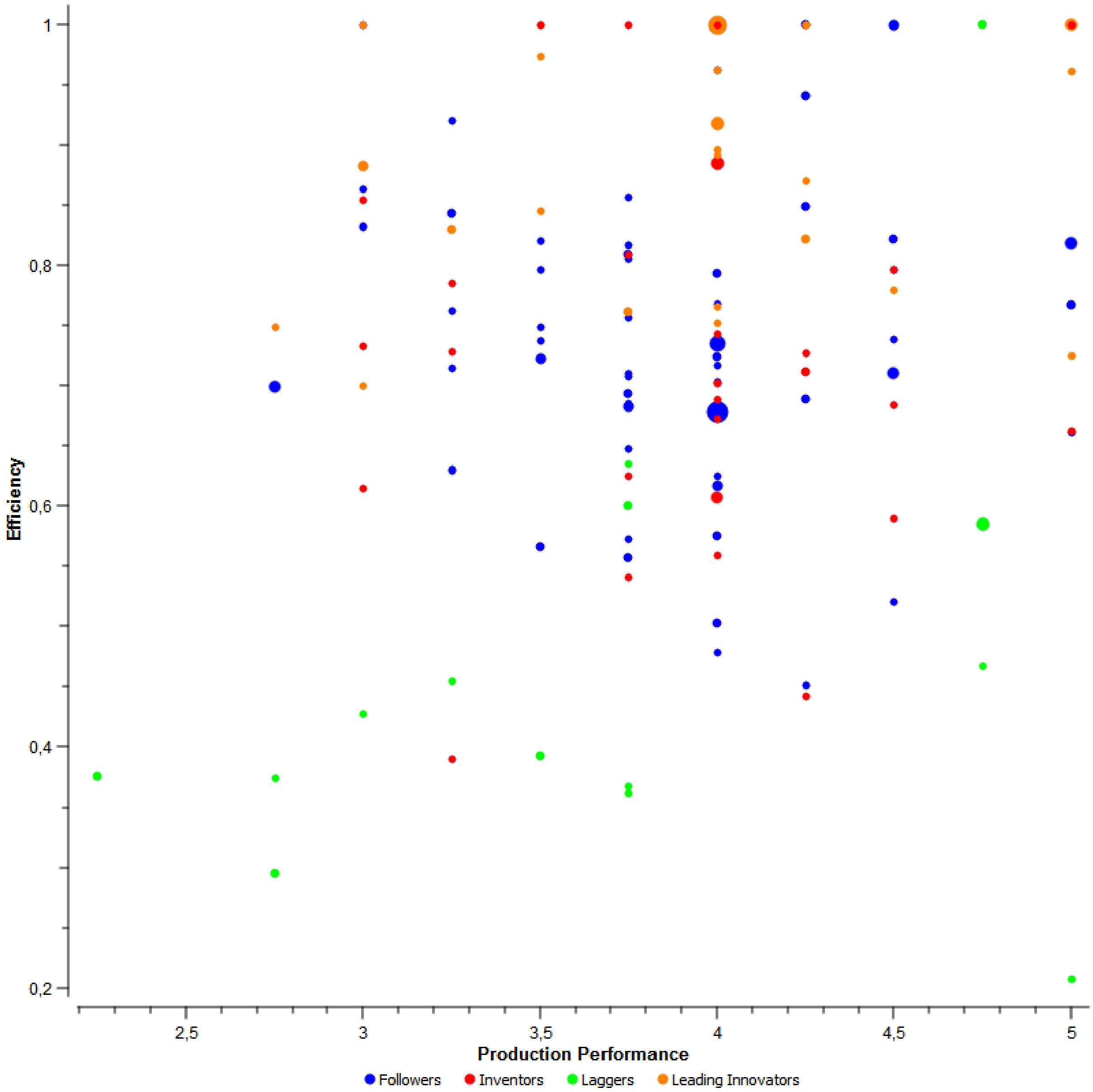


Figure 6.29. Efficiency vs. Production Performance

Figure 6.29 displays the figure comprising efficiency scores and production performance values.

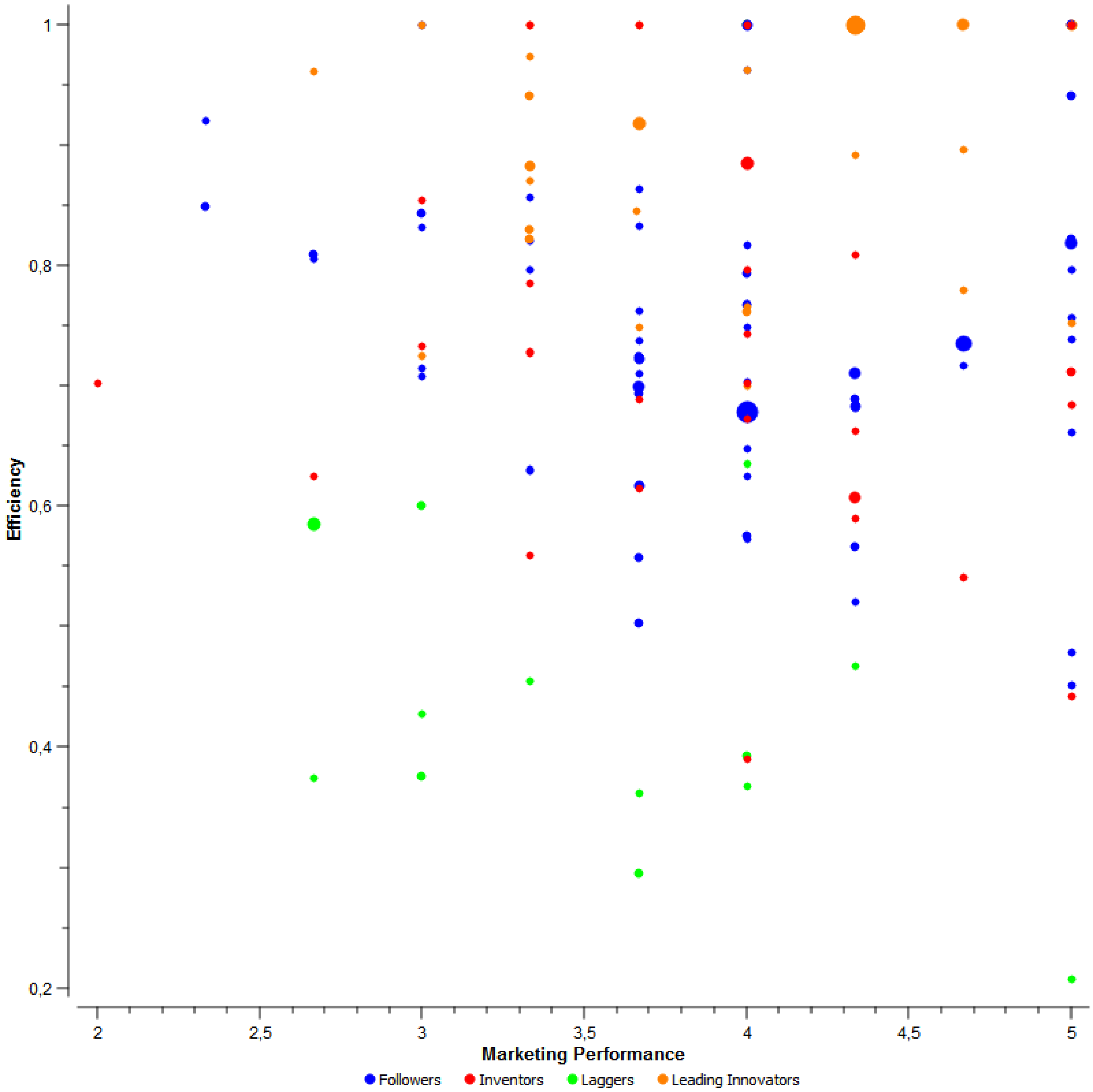


Figure 6.30. Efficiency vs. Marketing Performance

Figure 6.30 displays the figure comprising efficiency scores and marketing performance values.

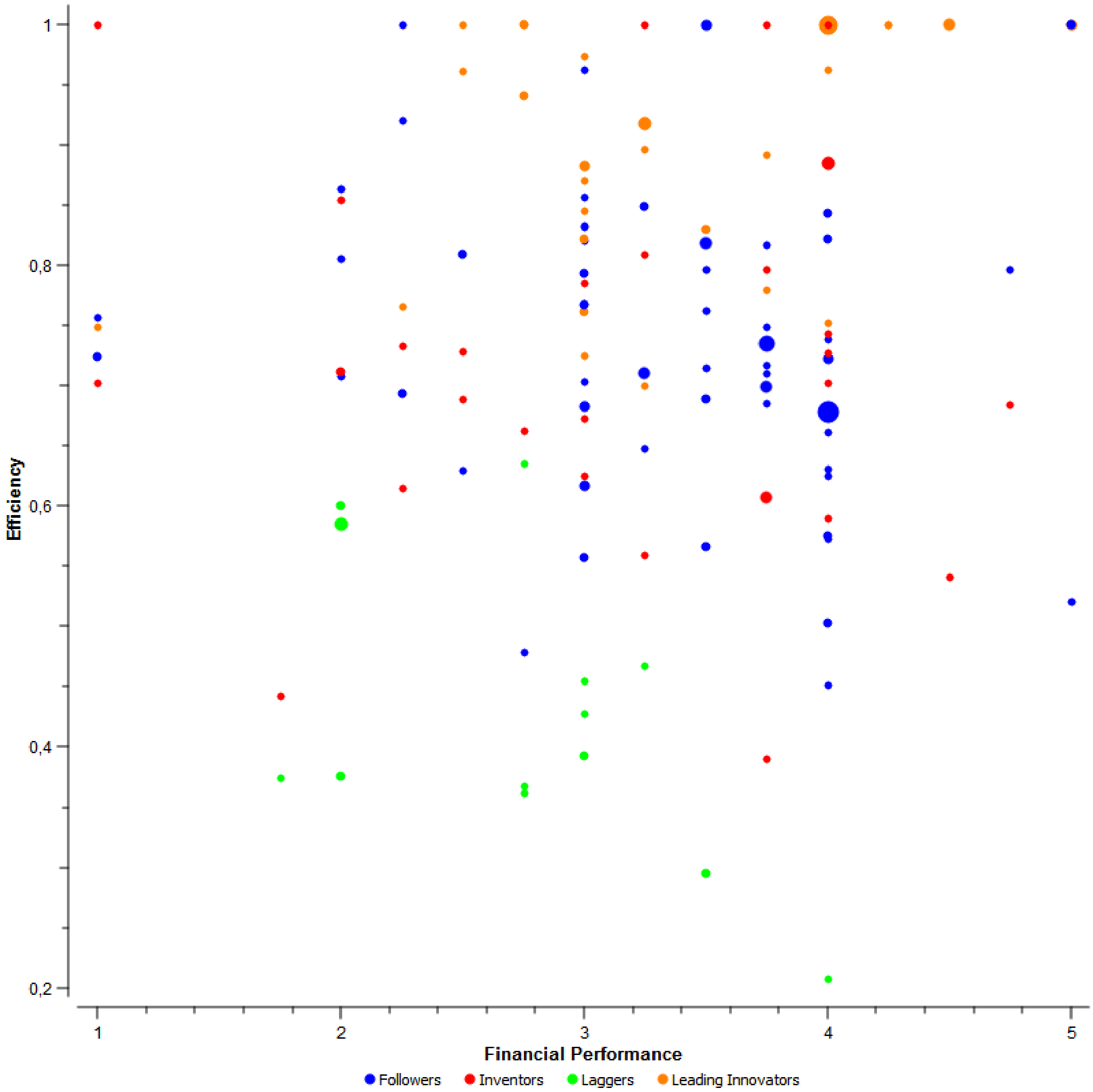


Figure 6.31. Efficiency vs. Financial Performance

Figure 6.31 displays the figure comprising efficiency scores and financial performance values.

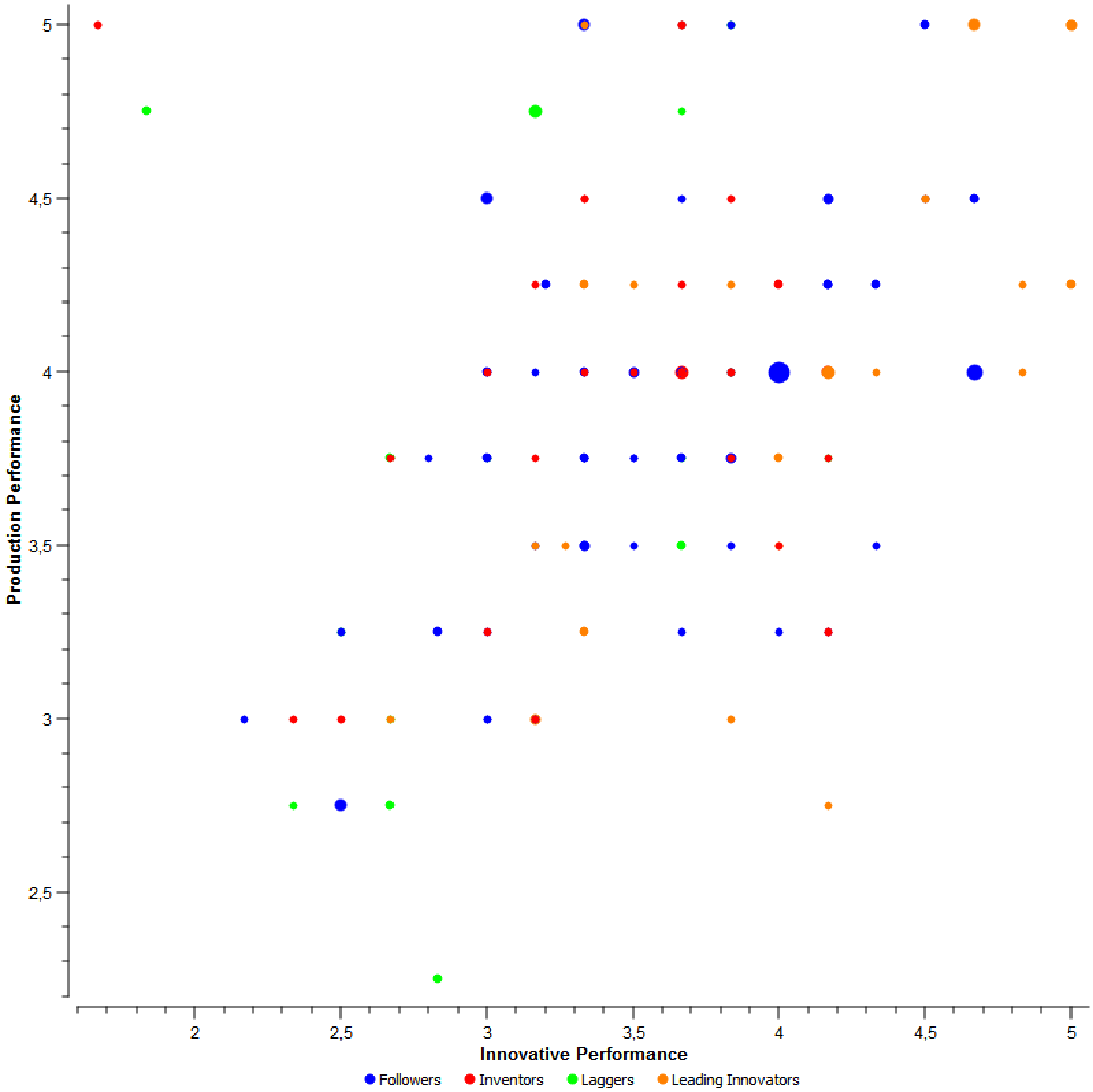


Figure 6.32. Production vs. General Innovation Performance

Figure 6.32 displays the figure comprising production values and innovative performance values.The figure suggests that firms can have both lower innovative and production performances, and lower efficiency scores. Exceptionally, firms can have extremely lower innovative performance scores (<2) and extremely higher production performance scores (>4.5), and this phenomenon is observed for the two terms positioned on the upper left corner of the figure.

6.3.3 DEA Results Ignoring Specialization

As a consequence of the specialization component left out, it was observed that there was a great number of firms with increased and decreased efficiency scores.

Table 6.17. Numbers of firms with increased or decreased efficiency scores

	Leading Innovators	Followers	Innovators	Laggers	Total
# of Firms with Increased Efficiency Scores	16	17	14	10	57
# of Firms with Decreased Efficiency Scores	25	64	20	12	121

Table 6.17 provides the number of firms with increased or decreased efficiency scores when specialization component was taken out of the analysis. It was remarkably noted that 64 firms in Followers cluster were greatly affected from the exclusion of the component.

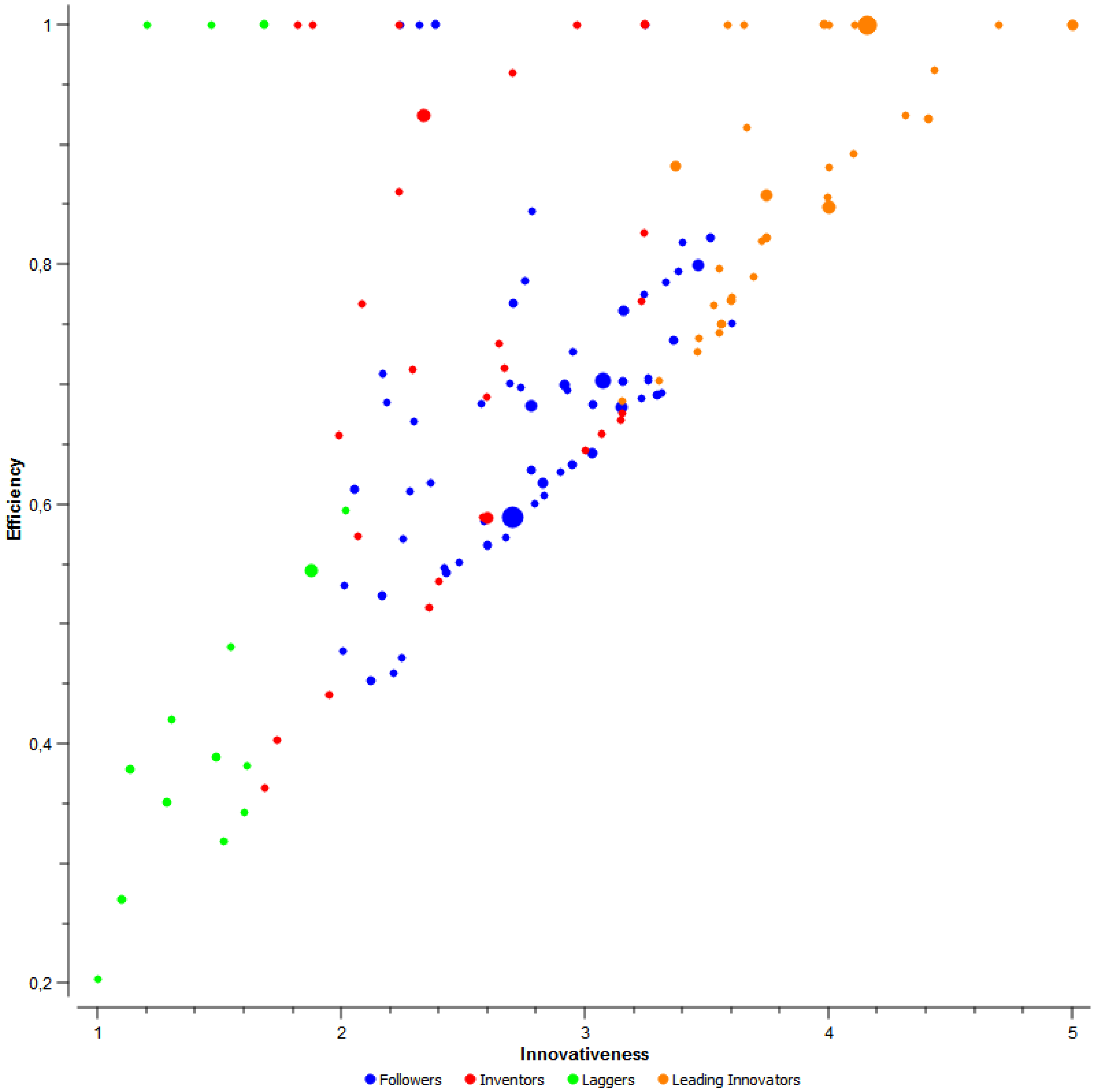


Figure 6.33. Efficiency vs. Innovativeness (Ignoring specialization)

Figure 6.33 displays the figure comprising efficiency scores and innovativeness values without the addition of specialization component. It is noted that the number of Laggers increased, while the number of Leading Innovators decreased.

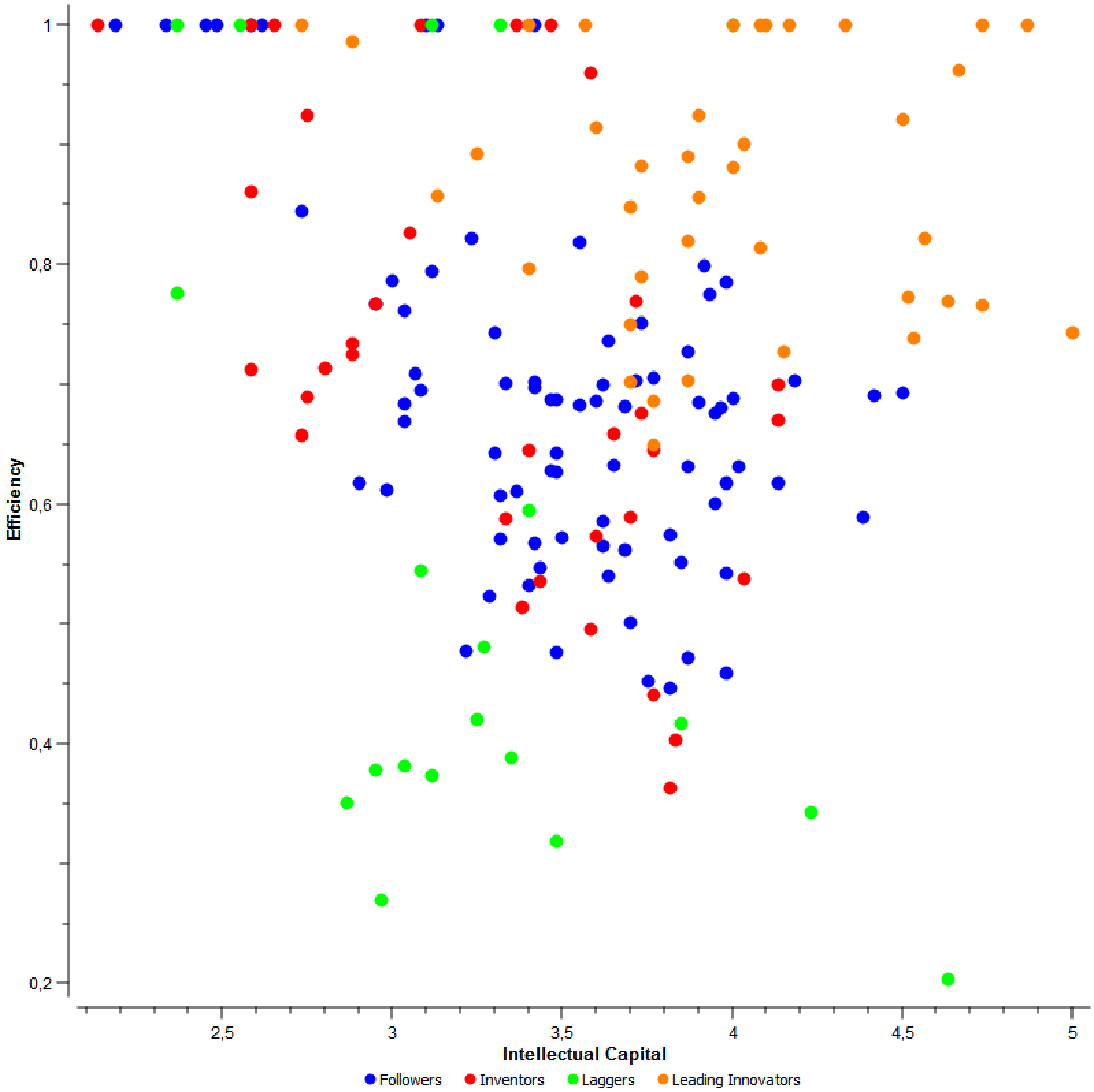


Figure 6.34. Efficiency vs. Intellectual Capital (Ignoring specialization)

Figure 6.34 displays the figure comprising efficiency scores and intellectual capital values without the addition of specialization component. We can make a similar observation as we have previously made for intellectual capital, this time with the addition of a more scattered visual. The number of Leading innovators decreased, while the number of Laggers increased. Again, the laggers are positioned on the lower half of the figure, whereas the leading innovators are located on the higher half.

	Innovativeness	Intellectual Capital	Organizational Structure	Organizational Culture	Barriers to Innovation	Collaborations	Monitoring
Innovativeness		0.4609	0.1523	0.3515	0.0935	0.2590	0.2938
Intellectual Capital	0.4609		0.3213	0.4454	0.3889	0.1795	0.4358
Organizational Structure	0.1523	0.3213		0.1813	0.2192	0.0767	0.1159
Organizational Culture	0.3515	0.4454	0.1813		0.2913	0.2178	0.4264
Barriers to Innovation	0.0935	0.3889	0.2192	0.2913		0.0629	0.2137
Collaborations	0.2590	0.1795	0.0767	0.2178	0.0629		0.3528
Monitoring	0.2938	0.4358	0.1159	0.4264	0.2137	0.3528	

Figure 6.35. Correlation Results (Ignoring Specialization)

Figure 6.35 displays the figure comprising correlation results of the drivers of innovativeness and the innovativeness values with the exclusion of specialization component.

6.4 Dichotomous Study

A dichotomous investigation was performed on the data in order to explore the statistical significances that are suggested by the taxonomy analysis, and not by a high-low categorization in terms of innovativeness. **Tables 6.18, 6.19 and 6.20** below present the normality results for Cut-Off Levels 2, 2.5 and 3, respectively. Test column provides the information of which test is applied as a result of the parametric or non-parametric nature of the dataset. Normally distributed entities were performed independent t-tests, while non-normally distributed entitites were tested with Mann-Whitney U test.

Table 6.18. Dichotomous Study Normality Results for Cut-Off Level 2

Driver/Component	Cut-Off Level 2 (147 High, 33 Low)		
	p-values		Test
	High	Low	
Intellectual Capital	0.168	0.111	t-test
Human Capital	0.023	0.126	Mann-Whitney U
Social Capital	0.038	0.508	Mann-Whitney U
Organizational Capital	0.001	0.276	Mann-Whitney U
Specialization	0.000	0.022	Mann-Whitney U
Organizational Structure	0.130	0.977	t-test
Centralization	0.134	0.145	t-test
Formalization	0.316	0.829	t-test
Communication	0.002	0.007	Mann-Whitney U
Organizational Culture	0.000	0.619	Mann-Whitney U
Management Support	0.001	0.704	Mann-Whitney U
Reward System	0.000	0.014	Mann-Whitney U
Work Discretion	0.002	0.395	Mann-Whitney U
Time Availability	0.000	0.291	Mann-Whitney U
Barriers to Innovation	0.611	0.720	t-test
Internal Resistance	0.002	0.582	Mann-Whitney U
Internal Deficiencies	0.040	0.026	Mann-Whitney U
Internal Limitations	0.042	0.868	Mann-Whitney U
External Difficulties	0.005	0.060	Mann-Whitney U
External Limitations	0.002	0.756	Mann-Whitney U
Monitoring	0.000	0.038	Mann-Whitney U
Outer Milieu	0.000	0.000	Mann-Whitney U
Inner Milieu	0.092	0.342	t-test
Open Innovation Resources	0.008	0.279	Mann-Whitney U
Collaborations	0.017	0.065	Mann-Whitney U
R&D Collaboration	0.000	0.000	Mann-Whitney U
Vertical Collaboration	0.000	0.000	Mann-Whitney U
Operational Collaboration	0.000	0.004	Mann-Whitney U

Table 6.19. Dichotomous Study Normality Results for Cut-Off Level 2.5

Driver/Component	**Cut-Off Level 2.5 (104 High, 76 Low)**		
	p-values		**Test**
	High	**Low**	
Intellectual Capital	0.563	0.424	t-test
Human Capital	0.110	0.021	Mann-Whitney U
Social Capital	0.037	0.132	Mann-Whitney U
Organizational Capital	0.003	0.040	Mann-Whitney U
Specialization	0.002	0.001	Mann-Whitney U
Organizational Structure	0.207	0.676	t-test
Centralization	0.230	0.041	Mann-Whitney U
Formalization	0.427	0.498	t-test
Communication	0.005	0.000	Mann-Whitney U
Organizational Culture	0.409	0.003	Mann-Whitney U
Management Support	0.121	0.047	Mann-Whitney U
Reward System	0.000	0.000	Mann-Whitney U
Work Discretion	0.049	0.061	Mann-Whitney U
Time Availability	0.000	0.002	Mann-Whitney U
Barriers to Innovation	0.809	0.108	t-test
Internal Resistance	0.011	0.036	Mann-Whitney U
Internal Deficiencies	0.135	0.173	t-test
Internal Limitations	0.113	0.569	t-test
External Difficulties	0.027	0.008	Mann-Whitney U
External Limitations	0.020	0.078	Mann-Whitney U
Monitoring	0.002	0.001	Mann-Whitney U
Outer Milieu	0.000	0.000	Mann-Whitney U
Inner Milieu	0.078	0.636	t-test
Open Innovation Resources	0.024	0.250	Mann-Whitney U
Collaborations	0.050	0.123	Mann-Whitney U
R&D Collaboration	0.000	0.000	Mann-Whitney U
Vertical Collaboration	0.000	0.000	Mann-Whitney U
Operational Collaboration	0.000	0.000	Mann-Whitney U

Cut-Off Level 2 has 147 High and 33 Low innovator firms. Cut-Off Level 2,5 has 104 High and 76 Low innovator firms and Cut-Off Level 3 has 67 High and 113 Low firms.

Table 6.20. Dichotomous Study Normality Results for Cut-Off Level 3

Driver/Component	Cut-Off Level 3 (67 High, 113 Low)		
	p-values		Test
	High	Low	
Intellectual Capital	0.671	0.275	t-test
Human Capital	0.208	0.029	Mann-Whitney U
Social Capital	0.181	0.054	t-test
Organizational Capital	0.008	0.002	Mann-Whitney U
Specialization	0.010	0.000	Mann-Whitney U
Organizational Structure	0.135	0.364	t-test
Centralization	0.462	0.047	t-test
Formalization	0.193	0.338	t-test
Communication	0.004	0.000	Mann-Whitney U
Organizational Culture	0.841	0.001	Mann-Whitney U
Management Support	0.391	0.004	Mann-Whitney U
Reward System	0.001	0.000	Mann-Whitney U
Work Discretion	0.060	0.013	Mann-Whitney U
Time Availability	0.002	0.000	Mann-Whitney U
Barriers to Innovation	0.824	0.486	t-test
Internal Resistance	0.007	0.035	Mann-Whitney U
Internal Deficiencies	0.191	0.050	Mann-Whitney U
Internal Limitations	0.071	0.306	t-test
External Difficulties	0.118	0.001	Mann-Whitney U
External Limitations	0.078	0.032	Mann-Whitney U
Monitoring	0.015	0.000	Mann-Whitney U
Outer Milieu	0.004	0.000	Mann-Whitney U
Inner Milieu	0.257	0.264	t-test
Open Innovation Resources	0.043	0.092	Mann-Whitney U
Collaborations	0.054	0.064	t-test
R&D Collaboration	0.000	0.000	Mann-Whitney U
Vertical Collaboration	0.000	0.000	Mann-Whitney U
Operational Collaboration	0.000	0.000	Mann-Whitney U

Tables 6.21, 6.22 and 6.33 display the p-values for Cut-Off Levels 2, 2.5 and 3 respectively. It is observed that as the distribution of the firms become more balanced, the distinguishing power of dichotomous against cluster based approach seems to improves, but never exceeds the distinguishing power of the cluster based approach.

Table 6.21. Dichotomous Study Mean Comparison Results for Cut-Off Level 2

Driver/Component	Cut-Off Level 2		Cluster-Based p-value	Cluster-Based Result
	p-value	Result		
Intellectual Capital	0.017	Supported	0.000	Supported
Human Capital	0.167	Not Supported	0.000	Supported
Social Capital	0.268	Not Supported	0.000	Supported
Organizational Capital	0.002	Supported	0.000	Supported
Specialization	0.180	Not Supported	0.012	Supported
Organizational Structure	0.380	Not Supported	0.179	Not Supported
Centralization	0.573	Not Supported	0.021	Supported
Formalization	0.591	Not Supported	0.418	Not Supported
Communication	0.192	Not Supported	0.059	Not Supported
Organizational Culture	0.196	Not Supported	0.008	Supported
Management Support	0.074	Not Supported	0.004	Supported
Reward System	0.276	Not Supported	0.046	Supported
Work Discretion	0.352	Not Supported	0.100	Not Supported
Time Availability	0.683	Not Supported	0.058	Not Supported
Barriers to Innovation	0.810	Not Supported	0.010	Supported
Internal Resistance	0.179	Not Supported	0.099	Not Supported
Internal Deficiencies	0.454	Not Supported	0.020	Supported
Internal Limitations	0.959	Not Supported	0.015	Supported
External Difficulties	0.329	Not Supported	0.196	Not Supported
External Limitations	0.705	Not Supported	0.210	Not Supported
Monitoring	0.083	Not Supported	0.001	Supported
Outer Milieu	0.156	Not Supported	0.000	Supported
Inner Milieu	0.073	Not Supported	0.000	Supported
Open Innovation Resources	0.048	Supported	0.060	Not Supported
Collaborations	0.156	Not Supported	0.159	Not Supported
R&D Collaboration	0.229	Not Supported	0.159	Not Supported
Vertical Collaboration	0.062	Not Supported	0.092	Not Supported
Operational Collaboration	0.607	Not Supported	0.559	Not Supported

Table 6.22. Dichotomous Study Mean Comparison Results for Cut-Off Level 2,5

Driver/Component	Cut-Off Level 2.5		Cluster-Based p-value	Cluster-Based Result
	p-value	Result		
Intellectual Capital	0.000	Supported	0.000	Supported
Human Capital	0.026	Supported	0.000	Supported
Social Capital	0.014	Supported	0.000	Supported
Organizational Capital	0.000	Supported	0.000	Supported
Specialization	0.010	Supported	0.012	Supported
Organizational Structure	0.026	Supported	0.179	Not Supported
Centralization	0.829	Not Supported	0.021	Supported
Formalization	0.105	Not Supported	0.418	Not Supported
Communication	0.014	Supported	0.059	Not Supported
Organizational Culture	0.001	Supported	0.008	Supported
Management Support	0.002	Supported	0.004	Supported
Reward System	0.002	Supported	0.046	Supported
Work Discretion	0.110	Not Supported	0.100	Not Supported
Time Availability	0.035	Supported	0.058	Not Supported
Barriers to Innovation	0.837	Not Supported	0.010	Supported
Internal Resistance	0.158	Not Supported	0.099	Not Supported
Internal Deficiencies	0.664	Not Supported	0.020	Supported
Internal Limitations	0.371	Not Supported	0.015	Supported
External Difficulties	0.195	Not Supported	0.196	Not Supported
External Limitations	0.689	Not Supported	0.210	Not Supported
Monitoring	0.001	Supported	0.001	Supported
Outer Milieu	0.006	Supported	0.000	Supported
Inner Milieu	0.000	Supported	0.000	Supported
Open Innovation Resources	0.009	Supported	0.060	Not Supported
Collaborations	0.000	Supported	0.159	Not Supported
R&D Collaboration	0.063	Not Supported	0.159	Not Supported
Vertical Collaboration	0.000	Supported	0.092	Not Supported
Operational Collaboration	0.022	Supported	0.559	Not Supported

Table 6.23. Dichotomous Study Mean Comparison Results for Cut-Off Level 3

Driver/Component	Cut-Off Level 3		Cluster-Based p-value	Cluster-Based Result
	p-value	Result		
Intellectual Capital	0.000	Supported	0.000	Supported
Human Capital	0.007	Supported	0.000	Supported
Social Capital	0.012	Supported	0.000	Supported
Organizational Capital	0.000	Supported	0.000	Supported
Specialization	0.001	Supported	0.012	Supported
Organizational Structure	0.004	Supported	0.179	Not Supported
Centralization	0.911	Not Supported	0.021	Supported
Formalization	0.009	Supported	0.418	Not Supported
Communication	0.040	Supported	0.059	Not Supported
Organizational Culture	0.000	Supported	0.008	Supported
Management Support	0.000	Supported	0.004	Supported
Reward System	0.000	Supported	0.046	Supported
Work Discretion	0.004	Supported	0.100	Not Supported
Time Availability	0.004	Supported	0.058	Not Supported
Barriers to Innovation	0.979	Not Supported	0.010	Supported
Internal Resistance	0.045	Supported	0.099	Not Supported
Internal Deficiencies	0.764	Not Supported	0.020	Supported
Internal Limitations	0.101	Not Supported	0.015	Supported
External Difficulties	0.063	Not Supported	0.196	Not Supported
External Limitations	0.403	Not Supported	0.210	Not Supported
Monitoring	0.002	Supported	0.001	Supported
Outer Milieu	0.008	Supported	0.000	Supported
Inner Milieu	0.000	Supported	0.000	Supported
Open Innovation Resources	0.045	Supported	0.060	Not Supported
Collaborations	0.002	Supported	0.159	Not Supported
R&D Collaboration	0.133	Not Supported	0.159	Not Supported
Vertical Collaboration	0.007	Supported	0.092	Not Supported
Operational Collaboration	0.031	Supported	0.559	Not Supported

Our findings demonstrate that when the threshold was considered to be 2, 2.5 and 3, there exists no statistical significance among the means of the firms in Barriers to Innovation driver of innovativeness, while there is a statistical significance when the firms are categorized in clusters. The same observation is made for centralization of organizational structure component, and internal deficiencies and internal limitations components of Barriers to Innovation. Taxonomy analysis is successful at capturing the significance among the groups compared to the dichotomous study.

CHAPTER 7

SUMMARY & CONCLUSION

7.1. Summary

The study conducted in this thesis proposes a drivers of innovativeness model and investigates on the relationship among the model entities through a dataset consisting of 184 Turkish manufacturing firms. A framework was developed based on a cluster analysis and the groups were tested statistically for group differences. The results obtained can be used to assist higher levels of management within the firms for aiding decision support systems and determining innovation policies and strategies. The hypotheses proposed in chapter 4 of this thesis were statistically tested and the results were reported. A summary of results are provided in **Table 7.1**, where the hypotheses supported and rejected are indicated. Underlined p-values denote the supported hypotheses, where as p-values with no underline prove no support for the hypothesis.

The hypotheses H1 to H6 related to drivers of innovativeness are presented in **Table 7.1**. We found support for intellectual capital, organizational culture, barriers to innovation and monitoring, while there exists no statistical evidence for organizational structure and collaborations.

Hypotheses related to *intellectual capital* components are supported without exception. There are statistical significances among cluster means for humanc, social capital, organizational capital and specialization.

Organizational structure hypotheses contained an investigation on the mean differences. There exists a statistical significance only for centralization component, and there is no support for formalization and communication.

Firms in our study *organizational culture* are different when examined cluster-wise in terms of management support and reward systems, and there is no difference among cluster means in work discretion and time availability components.

The statistical investigation of *barriers to innovation* driver of innovativeness yielded significance among clusters in internal deficiencies and internall. There exists no statistical significance among cluster means for internal resistance, external difficulties and external limitations.

Monitoring driver was supported under its components monitoring the outer and inner milieu, while there exists no statistical significance for monitoring open innovation resources.

Collaboration driver was examined among the clusters and we found no statistical evidence for different cluster means for each of the collaboration types.

Table 7.1. Hypothesis Testing Results

#	Hypothesis		p-value	Result
H_1	Intellectual Capital		0.000	Supported
H_{1a}		Human Capital	0.000	Supported
H_{1b}		Social Capital	0.000	Supported
H_{1c}		Organizational Capital	0.000	Supported
H_{1d}		Specialization	0.012	Supported
H_2	Organizational Structure		0.179	Not Supported
H_{2a}		Centralization	0.021	Supported
H_{2b}		Formalization	0.418	Not Supported
H_{2c}		Communication	0.059	Not Supported
H_3	Organizational Culture		0.008	Supported
H_{3a}		Management Support	0.004	Supported
H_{3b}		Reward System	0.046	Supported
H_{3c}		Work Discretion	0.100	Not Supported
H_{3d}		Time Availability	0.058	Not Supported
H_4	Barriers to Innovation		0.010	Supported
H_{4a}		Internal Resistance	0.099	Not Supported
H_{4b}		Internal Deficiencies	0.020	Supported
H_{4c}		Internal Limitations	0.015	Supported
H_{4d}		External Difficulties	0.196	Not Supported
H_{4e}		External Limitations	0.210	Not Supported
H_5	Monitoring		0.001	Supported
H_{5a}		Outer Milieu	0.000	Supported
H_{5b}		Inner Milieu	0.000	Supported
H_{5c}		Open Innovation Resources	0.060	Not Supported
H_6	Collaborations		0.159	Not Supported
H_{6a}		R&D Collaboration	0.159	Not Supported
H_{6b}		Vertical Collaboration	0.092	Not Supported
H_{6c}		Operational Collaboration	0.559	Not Supported

Notes: Underlined values indicate statistical significance at α=0.05.

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