MTU - JBMS

Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi
Malatya Turgut Özal University Journal of Business and Management Sciences

ISSN: 2717-7890

***Cilt/Volume**:5, **Sayı/Issue:**2, **Yıl/Year:**2024, **Sayfa/Page**:202-242, **ISSN:** 2717-7890*

MEASURING THE IMPACT OF INTELLECTUAL CAPITAL ON FIRM PERFORMANCE IN THE INFORMATION TECHNOLOGY SECTOR: THE IMPORTANCE OF INNOVATION CAPITAL

Bilişim Sektöründe Entelektüel Sermayenin Firma Performansına Etkisinin Ölçülmesi: İnovasyon Sermayenin Önemi

Seda ERDOĞAN*

Mihriban COŞKUN ARSLAN**

* *Doktora Öğrencisi, Tokat Gaziosmanpaşa Üniversitesi,* erdoganades@gmail.com *, ORCID: 0000-0002-4648-1925*

***Prof. Dr., Tokat Gaziosmanpaşa Üniversitesi, mihriban.arslan@gop.edu.tr , ORCID: 0000-0002-6196-9304*

Tez Özeti / Dissertation

Received Date:
13.09.2024
Acceptance Date:
11.10.2024

Keywords:
Intellectual Capital, Innovation, Firm Performance, Information Technology Sector

JEL Codes:
M40, M49

Similarity Rate:
%6

ABSTRACT

Intellectual capital is defined as using all kinds of knowledge, expertise, experience, and intellectual property to create value in businesses. Therefore, intellectual capital is considered one of the critical drivers for competition and value creation among firms in today's conditions, where the knowledge economy dominates. Measuring every asset that generates value within the business and analyzing its impact on financial performance has become one of the essential issues. This study examines the effect of intellectual capital on firm performance and the relationship between innovation investments and firm performance. The primary aim of this study is to comprehensively analyze how innovation capital affects the relationship between intellectual capital and firm performance. The research examined the effects of intellectual capital components on firm performance while evaluating how innovation capital alters and strengthens this relationship. In the scope of the research, the intellectual capital performance of information technology firms operating in Turkey between 2010-2022, listed on Borsa Istanbul (BIST), and including research and development expenditures in their financial reports, was measured using the Value Added Intellectual Coefficient (VAIC) method."According to the study results, the efficiency of physical capital, human capital, structural capital, and innovation capital positively affected return on assets (ROA). It was determined that the efficiency of physical capital, human capital, and innovation capital positively impacted return on equity (ROE). Additionally, it was found that the efficiency of physical capital, human capital, and innovation capital positively influenced earnings per share (EPS), while structural capital efficiency negatively affected it. Finally, it was determined that the efficiency of human capital and innovation capital positively impacted the price-to-book (P/B) ratio, and the efficiency of structural capital positively affected asset turnover (ACS) and value-added (VA).

Geliş Tarihi:
13.09.2024
Kabul Tarihi:
11.10.2024

Anahtar Kelimeler:
Entelektüel Sermaye, İnovasyon, Firma Performansı, Bilişim Sektörü

JEL Kodları:
M40, M49

Benzerlik Oranı:
%6

ÖZ

Entelektüel sermaye işletmelerde değer ortaya çıkarabilmek için kullanılan her türlü bilgi, bilgi birikimi, deneyim ve fikri mülkiyetin kullanımı olarak ifade edilmektedir. Bu sebeple, entelektüel sermaye, bilgi ekonomisinin hâkim olduğu günümüz koşullarında firmalar arası rekabet ve değer ortaya çıkarılması için önemli itici güçlerden biri olarak görülmektedir. İşletmede değer ortaya koyan her varlığın ölçülmesi ve finansal performansa etkisinin analiz edilmesi önem arz eden konulardan biri olmuştur. Çalışmada entelektüel sermayenin firma performansı üzerindeki etkisi ve inovasyon yatırımlarının firma performansı arasındaki ilişki incelenmiştir. Bu çalışmanın temel amacı, inovasyon sermayesinin entelektüel sermaye ile firma performansı arasındaki ilişkiyi nasıl etkilediğini kapsamlı bir şekilde incelenmesidir. Araştırmada, entelektüel sermaye bileşenlerinin firma performansı üzerindeki etkileri değerlendirilirken, inovasyon sermayesinin bu ilişkiyi nasıl değiştirdiği ve güçlendirdiği

MTU - JBMS
Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi
Malatya Turgut Özal University Journal of Business and Management Sciences
ISSN: 2717-7890
***Cilt/Volume**:5, **Sayı/Issue:**2, **Yıl/Year:**2024, **Sayfa/Page**:202-242, **ISSN:** 2717-7890*

analiz edilmiştir. Araştırma kapsamında 2010-2022 yılları arasında Türkiye'de faaliyet gösteren, Borsa İstanbul (BİST)'da işlem gören ve finansal raporlarında araştırma geliştirme giderlerine yer veren bilişim firmalarının entelektüel sermaye performansı Entelektüel Katma Değer Katsayısı (VAIC) yöntemiyle ölçülmüştür. Araştırmanın sonuçlarına göre; maddi sermaye, insan sermayesi, yapısal sermaye ve inovasyon sermayesi etkinliklerinin aktif karlılığını (ROA) pozitif yönde etkilediği görülmüştür. Maddi sermaye, insan sermayesi ve inovasyon sermayesi etkinliklerinin özsermaye karlılığını (ROE) pozitif yönde etkilediği tespit edilmiştir. Maddi sermaye, insan sermayesi ve inovasyon sermayesi etkinliklerinin hisse başına karı (EPS) pozitif yönde etkilediği, yapısal sermaye etkinliğini negatif yönde etkilediği görülmüştür. İnsan sermayesi ve inovasyon sermayesi etkinliklerinin piyasa değeri/defter değeri oranını (P/B) pozitif yönde etkilediği son olarak yapısal sermaye etkinliğinin aktif devir hızı (ACS) ve katma değeri (VA) pozitif yönde etkilediği tespit edilmiştir.

Atıf / Citation: Erdoğan. S. & Arslan C. M. (2024). Measuring The Impact of Intellectual Capital on Firm Performance In The Information Technology Sector: The Importance of Innovation Capital. *Malatya Turgut Ozal University Journal of Business and Management Sciences,* 5(2) 202-242.

1. INTRODUCTION

During the transition from an agricultural economy to an industrial economy and from an industrial economy to a knowledge economy, various significant changes have occurred, especially concerning production factors and financial performance indicators. In the past, land and capital were seen as the most important sources of wealth, but today, producing knowledge has become one of the essential sources of wealth. Information technologies, influenced by competition and globalization, have spread worldwide. While businesses' financial indicators in the past consisted of raw materials, capital, and machinery, today they are composed of brand, intellectual capital, customer loyalty, skills, knowledge productivity, technology, information, intangible assets, virtuality, and innovation. Therefore, firms have opted to reduce their physical components and expand their intellectual components (Stewart, 1997: 48-49; Yıldız, 2010: 3-4; Karacan, 2007: 2). While some of the assets created by firms are included in financial statements, others are reported as invisible information assets due to their non-financial nature. Every piece of knowledge, invention, and innovation generates value. This value, in turn, enhances the firm's financial performance, thus increasing the importance of intellectual capital.

Information technology is among the sectors where knowledge is most intensively used. Knowledge only produces financial outcomes when it is transformed into a sellable value. Therefore, the financial statements of firms operating in the information technology sector include more intangible assets than tangible ones. Although intellectual capital is continuously researched in Turkey and globally, studies investigating its effects and contributions to the IT sector are limited. It is predicted that measuring the impact of intellectual capital elements and innovation capital on the financial performance of firms in the IT sector, where knowledge is most produced, and innovative work is highly conducted, will provide significant contributions to the firms and researchers in this sector.

This study addresses the concept of intellectual capital, its elements, a literature review, and the measurement and interpretation of intellectual capital based on the Value-Added Intellectual Coefficient (VAIC) method. Including innovation capital in the variables used in the VAIC method calculations is essential for demonstrating how research and development investments affect the financial performance of firms operating in the IT sector, thus contributing to the literature. The research involves panel regression data analysis using data from the financial

MTU - JBMS
Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi
Malatya Turgut Özal University Journal of Business and Management Sciences
ISSN: 2717-7890
Cilt/Volume:5, Sayı/Issue:2, Yıl/Year:2024, Sayfa/Page:202-242, ISSN: 2717-7890

statements of IT firms in Turkey, listed on Borsa Istanbul (BIST), and reporting research and development expenditures in their financial reports between 2010 and 2022. The most commonly used financial performance metrics in the literature, such as Return on Assets (ROA), Return on Equity (ROE), Earnings per Share (EPS), Price-to-Book Ratio (P/B), Asset Turnover (ACS), and Value Added (VA), were employed. To test the hypotheses set out in line with the research objective, leverage ratio, firm size, and physical capital intensity were also included as control variables in the models.

2. INTELLECTUAL CAPITAL, ITS COMPONENTS AND MEASUREMENT

Intellectual capital is a critical topic for firms because it offers a competitive advantage in the market, increases market value, enhances financial performance, enables the achievement of long-term plans and strategic goals, fosters customer loyalty, provides funding for the business, offers promotion and career opportunities, increases sales while reducing costs, and contributes to countries' gross domestic product (GDP) by influencing the market overall. Additionally, it helps uncover new knowledge supported by empirical arguments.

With the rise of technology, innovation, and globalization, competitiveness has become one of the most critical issues for firms to ensure their survival. Researchers such as Hall (1992), Stewart (1998), and Pablos (2003) frequently emphasize the necessity of producing high-value-added products, improving intangible assets, and strengthening intellectual capital. The literature provides various definitions of intellectual capital. Table 1 below presents the definitions related to intellectual capital.

Table 1: Definitions of Intellectual Capital

Author	Term	Concept Definition
İtami (1991)	Invisible Assets	Intangible assets; these are invisible assets that include a variety of activities such as technology, consumer trust, brand image, corporate culture, and management skills.
Hall (1992)	Intangible Assets	Intangible assets are forces that contribute to the formation of value, transforming productive resources into value-added assets.
Smith (1994)	Intellectual Property	Intangible assets are all the elements of a business's working capital and fixed assets. These elements contribute to the company's ability to generate income and are primarily responsible for the company's profitability. Their presence is linked to the existence or expectations of profits.
Brooking (1997)	Intellectual Capital	Market assets, human-centered assets, intellectual property assets, and infrastructure assets.
Edvinsson ve Malone (1997)	Intellectual Capital and Intangible Assets	Intangible assets are non-physical but valuable to the company.

MTU - JBMS
Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi
Malatya Turgut Özal University Journal of Business and Management Sciences
ISSN: 2717-7890
Cilt/Volume:5, Sayı/Issue:2, Yıl/Year:2024, Sayfa/Page:202-242, ISSN: 2717-7890

Sveiby (1997)	Intangible Values	Intellectual capital has three dimensions: employee competence, internal structure, and external structure.
Nahapiet ve Ghoshal (1998)	Intellectual Capital	The organization is described as the knowledge and ability to know, social integration like intellectual community or professional practice.
Stewart (1998)	Intellectual Capital	Intellectual capital is intellectual material, knowledge, know-how, intellectual property, experience, and collective brainpower that can be used to generate wealth.
Granstrand (1999)	Intellectual Property	Intellectual Property is a characteristic directly related to a person's knowledge creation and identity.
Brennan ve Connell (2000)	Intellectual Capital	It is the knowledge-based equity of a company.
Harrison ve Sullivan (2000)	Intellectual Capital	Information that can be converted into profit.
Sullivan (2000)	Intellectual Capital	Information that can be converted into profit.
Heisig ve diğ. (2001	Intellectual Capital	Intellectual Capital is valuable but invisible.
Lev (2001)	Intangible Fixed Assets	Intangible fixed assets are future benefits that have no physical or financial (such as stocks or bonds) representation.
Gu ve Lev (2001	Intangible Assets	Intangible fixed assets are defined by research and development, information technologies, and human resources practices.
FASB (2001)	Intangible Assets	Intangible assets are non-financial rights with no physical or financial maturity that provide benefits.
Petty ve Guthrie (2000)	Intellectual Capital	Intellectual capital refers to the economic value of two categories of a company's intangible assets: organizational and human capital.
Pablos (2003)	Intellectual Capital	Intellectual capital, according to its broad definition, is the difference between a company's market value and book value. Knowledge-based resources that contribute to a firm's sustainable competitive advantage form intellectual capital
Rastogi (2003)	Intellectual Capital	Intellectual Capital can be seen as a holistic or meta-level ability to coordinate, organize, and distribute knowledge resources to generate value for a company's future vision.

MTU - JBMS
Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi
Malatya Turgut Özal University Journal of Business and Management Sciences
ISSN: 2717-7890
Cilt/Volume:5, Sayı/Issue:2, Yıl/Year:2024, Sayfa/Page:202-242, ISSN: 2717-7890

Mouritsen ve diğ. (2004)	Intellectual Capital	Intellectual capital activates things like employees, customers, information technologies, managerial work, and knowledge. Intellectual capital alone does not mean anything; it provides a mechanism allowing various assets to come together in the company's production process.
IASB (2004)	Intangible Fixed Assets	Intangible fixed assets are defined as non-monetary assets without physical substance that are held for production, supply of goods or services, renting to others, or for administrative purposes

***Source**: (Choong, 2008: 610-611)*

Since the early 1990s, various concepts and elements have defined intellectual capital. Based on these definitions, researchers categorize these assets as intangible fixed assets. Researchers, such as Pablos (2003), who define intellectual capital as the difference between market value and book value, emphasize the concept of value creation. They argue businesses will create added value and gain a competitive advantage by utilizing knowledge-based resources. Brennan and Connell (2000) and Harrison and Sullivan (2000), who build on the value creation perspective, define intellectual capital as the sum of the knowledge used in the value creation process. They argue that businesses that increase their intellectual capital will also see an increase in their profits. Other researchers, such as Itami (1991), Hall (1992), Edvinsson and Malone (1997), Sveiby (1997), Lev (2001), and Gu and Lev (2001), use terms like intangible fixed assets and invisible assets instead of intellectual capital. A common characteristic of these researchers is that they define intellectual capital by breaking it down into its components. Although there are differences among researchers who categorize intellectual capital, it is generally divided into human capital, structural capital, and customer capital. In conclusion, the definitions made by researchers vary due to the disciplines they work in (accounting, economics, finance, etc.) and the methods they choose to measure or report intellectual capital.

2.1. Components of Intellectual Capital

Intellectual capital can consist of various components such as human capital, structural capital, relational capital, customer capital, competitive capital, supply source capital, social capital, community capital, agreement capital, and regulatory capital. This diversity stems from the orientations and perspectives of researchers who classify intellectual capital differently, as seen in the various definitions of intellectual capital made by different researchers (Ercan et al., 2003: 110). Although the components of intellectual capital are classified differently in the literature, they fundamentally consist of human capital, structural capital, and customer capital.

Human Capital: Despite continuous advancements in technology and innovation, the need for human power will always remain. In its simplest form, human capital consists of concepts such as knowledge, education, talent, and experience created by employees in a business (Castro and Verde, 2012: 46; Karacan, 2007: 27). The knowledge produced by an individual working in a business can leave with that person when they leave the company. Therefore, human capital has the characteristics of being both acquired and renewable. Since human capital is directly composed of the human element, businesses cannot possess infinite human capital. As a result, companies are in the position of merely renting human capital. Growth-oriented enterprises do

MTU - JBMS
Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi
Malatya Turgut Özal University Journal of Business and Management Sciences
ISSN: 2717-7890
***Cilt/Volume**:5, **Sayı/Issue:**2, **Yıl/Year:**2024, **Sayfa/Page**:202-242, **ISSN:** 2717-7890*

not only employ intelligent people but also organize continuous training to develop their employees, aiming to maximize their performance (Yıldız, 2010: 59-60).

Human capital is described as the source of invention and the fountain of understanding. Through the knowledge they produce, humans create many innovations that facilitate social life. Even though an innovation may become outdated after a while, it is often further developed through new studies, leading to even more critical innovations. Thus, although machines usually outperform humans in productivity, they cannot invent. In a business, human capital is inventiveness that emerges through new product and service development and the improvement of business processes. Human capital is created and utilized when employees direct their time and talents toward innovative activities (Stewart, 1997: 134-135).

Structural Capital: This refers to the firm's ability to convert the values created by human capital produced by employees into the company's property. In other words, structural capital will emerge if the idea that the knowledge produced belongs to the business can be ingrained. A company with highly knowledgeable employees cannot demonstrate its human capital unless it has a strong structure (Yıldız, 2010: 67; Karacan, 2007: 29). From this perspective, human capital and structural capital nurture each other. Stewart (1997) compares human capital to the sap running under the bark of a tree (the essence that enables renewal and growth) and structural capital to the solid wood that grows. Therefore, the role of company management is to absorb knowledge into the company, retain it, and turn it into company property. Unlike other intellectual capital components, structural capital does not emerge as new knowledge but instead connects the various components of intellectual capital.

The knowledge that doesn't leave the office at night is referred to as structural capital (Stewart, 1997: 161). Therefore, structural capital belongs to the firm as a whole. Structural capital is renewable, shareable, securable, and sellable. Elements of structural capital include patents, copyrights, design rights, trade secrets, and trademarks.

Customer Capital: Every company that has customers also has customer capital. Customer capital is defined as the value of the company's reputation and its ongoing relationships with people and organizations to whom it sells. Customer capital is the most visible of the three components of intellectual capital. After all, the people who pay the bills are the company's customers. Because it is easier to track indicators such as market share, customer retention and churn rates, and profitability per customer, which reflect customer capital, it is customer capital that leaves the most traces in financial reporting (Stewart, 1997: 203).

Customer capital is considered one of the critical elements providing a competitive advantage in the knowledge economy. Customer capital represents the value of a business's relationships, contributing to current and future income. Therefore, maintaining solid customer relationships and continually offering products and services that meet their needs are crucial for the company's sustainability and growth. Customer capital components include brands, partnerships, licensing agreements, customer satisfaction, customer loyalty, image, business name, and distribution channels (Yıldız, 2010: 79; Karacan, 2007: 34).

***Cilt/Volume**:5, **Sayı/Issue:**2, **Yıl/Year:**2024, **Sayfa/Page**:202-242, **ISSN:** 2717-7890*

2.2. Methods of Measuring Intellectual Capital

As the impact of intellectual capital on value creation has increased, researchers have accelerated their efforts to measure this type of capital. In 1980, Itami investigated the reason for the performance differences observed in Japanese firms and linked these differences to intangible assets. In a book published in 1986 by Karl-Eric Sveiby, Itami's examinations of the impact of intangible assets were included. In the same year, David Teece, in his article titled "Profiting from Technological Innovation," examined the effects of technological innovations on value creation. By 1991, intellectual capital, whose importance was recognized by companies, ceased to be merely an area of individual research and became one of the significant management areas for businesses. In 1991, Skandia established an intellectual capital department under the leadership of Leif Edvinnson. In 1993, The Chemical Company formed an intellectual asset management department aimed at generating ideas for revenue creation and monetizing these ideas. Additionally, two articles published by Stewart in 1991 and 1994 emphasized the concept of "brainpower" and discussed the effects of intellectual capital management on profitability and growth (Ercan et al., 2003: 120-121).

Intellectual capital measurement has provided significant advantages over time, such as performance evaluation and business competitive advantage. Companies that recognize the importance of measuring intellectual assets have developed measurement methods suitable for their business processes. Since measuring, evaluating, and reporting intellectual capital is a relatively new field, and companies in different sectors have developed their unique measurement methods, there is no universal measurement method (Kızıl, 2010: 58; Yıldız, 2010: 101). The literature has two main approaches to measuring intellectual capital: one that measures intellectual capital as a whole and another that measures intellectual capital based on its components. The summary of these two basic approaches is to measure intellectual capital using financial and non-financial measurement methods (Tan et al., 2007: 78).

According to methods that measure intellectual capital from a financial perspective, the share of intellectual capital within the company's market value is presented as uncertain results. The general limitation of these methods is their inability to reveal the impact of intellectual capital components on value (Ercan et al., 2003: 128). Methods that measure intellectual capital (financial measurement methods) include the Market Value/Book Value Method, the Tobin Q Ratio Method, the Calculated Intangible Value Method, and the Economic Value-Added Method (Tan et al., 2007: 78).

Methods that measure intellectual capital based on components are developed using financial data, identifying intellectual capital components and tracking their development over time. The components of intellectual capital are determined according to the business's operational areas. After selecting the components, criteria suitable for the characteristics of those components are used (Ercan et al., 2003: 134). Researchers who measure intellectual capital based on components using financial data include those mentioned below. Edvinsson, a key researcher, introduced the term "Skandia Navigator" and developed a new and pioneering measurement model in this field. The 1994 report titled "Visualizing Intellectual Capital at Skandia" by Skandia, a company operating in the insurance and finance sectors in Sweden, set an example for many firms in managing and reporting intellectual capital. Following this, many consultancy firms and researchers have worked on new measurement and valuation models. Some of these include the Balanced Scorecard by Kaplan and Norton in 1996, the Technology Broker by Brooking in the

MTU - JBMS
Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi
Malatya Turgut Özal University Journal of Business and Management Sciences
ISSN: 2717-7890
Cilt/Volume:5, Sayı/Issue:2, Yıl/Year:2024, Sayfa/Page:202-242, ISSN: 2717-7890

same year, the Intangible Assets Monitor by Sveiby in 1997, the MERITUM Guidelines in 2001, and the Danish Intellectual Capital Statements Guide in 2003.

This study used the Value-Added Intellectual Coefficient (VAIC) method, developed by Ante Pulic in 1997. This method measures intellectual capital based on its components. The VAIC method was preferred in this research because it allows access to desired values from company balance sheets without extensive research, takes the concept of value-added into account, and provides an opportunity for comparable analysis. Details about the VAIC method are included in the methodology section of the study.

3. LITERATURE

Numerous national and international studies concerning intellectual capital components, measurement, accounting, and reporting are in the literature. This research examines studies measuring and reporting intellectual capital within the study's purpose and method. In line with the methodology used in the survey, summaries of the work of researchers who utilized the VAIC model to measure intellectual capital are provided below.

Öztürk and Demirgüneş (1997): In their study, they used the financial data of 30 manufacturing firms listed on the Istanbul Stock Exchange between 2000-2002 and applied the VAIC method to conduct multiple regression analysis to determine the impact of intellectual capital on firm value. The study found that the independent variables affecting profitability, efficiency, and market value were capital efficiency and structural capital efficiency. In contrast, human capital only influences firms' market value/book value ratio.

Ercan et al. (2003): Their study examined the 2002 data of 9 banks operating in Turkey using the VAIC method and correlation analysis. The results showed no strong relationship between value-added efficiency and the banks' profitability. However, they found a positive relationship between value-added efficiency derived from structural capital and profitability. In contrast, a negative relationship was found between value-added efficiency derived from employed capital and human capital and profitability. Banks that used their physical assets more effectively to generate revenue had higher market values. They concluded that banks in Turkey give more importance to tangible assets than intellectual capital assets.

Bontis (2004): Bontis developed a National Intellectual Capital Index (NICI) based on the conceptual framework of Skandia Navigator. NICI aims to reveal and manage a nation's intangible wealth in five key areas. The NICI model links market capital, renewal capital, process capital, and human capital to explore a nation's intellectual wealth. Based on his model, Bontis compared different Arab countries, concluding that national intellectual capital in Arab countries constitutes 20% of their financial wealth.

Goh (2005): In his study, Goh measured the intellectual capital performance of 16 commercial banks operating in Malaysia between 2001-2003 using the VAIC model. The study found that, overall, the human capital efficiency of all banks was higher than structural and capital efficiency. Local banks were generally found to be less efficient compared to foreign banks.

Huang and Liu (2005): Their study sought answers to the questions, "Is there a non-linear relationship between investments in innovation capital and information technology (IT) capital

Cilt/Volume:5, Sayı/Issue:2, Yıl/Year:2024, Sayfa/Page:202-242, ISSN: 2717-7890

and firm performance?" and "Does the interaction between innovation capital and IT capital have a synergistic effect on firm performance?" The study used multiple regression models, with key findings showing that investments in innovation capital positively impacted performance. Still, when these investments exceeded optimal levels, they hurt performance. IT capital had no significant impact on firm performance. However, after evaluating the interaction between innovation capital and IT capital, it positively affected firm performance.

Ng W. A. (2006): Ng examined the interrelationships between the components of intellectual capital in wireless technology companies based in Canada from a resource-based perspective and analyzed the gaps in financial reporting related to intellectual capital through case studies. As a result, a reciprocal relationship between intellectual capital components and firms' growth performance was confirmed.

Tan et al. (2007): In their study, Tan et al. explained the relationship between firms' intellectual capital (IC) and their financial performance using the Partial Least Squares (PLS) method with data from 150 companies listed on the Singapore Stock Exchange between 2000-2002. They concluded that there is a positive relationship between intellectual capital and company performance, that intellectual capital is related to future company performance, that a company's intellectual capital growth rate is positively associated with company performance, and that the contribution of intellectual capital to company performance may vary by industry.

Kayalı et al. (2007): In their study, they used the VAIC model to investigate the effects of intellectual capital on firm valuation for nine technology firms listed on the Istanbul Stock Exchange using correlation and multiple regression analysis. The results of the correlation analysis showed that only human capital had a positive and robust effect on the efficiency of technology firms. In contrast, the effect decreased as capital costs increased. No statistically significant effect was found in the multiple regression analysis. As a result, it was stated that technology firms in Turkey do not give enough importance to intellectual capital.

Using correlation and multiple regression analysis, Yörük and Erdem (2008) used the VAIC model to examine the performance of 12 automotive firms listed on the Istanbul Stock Exchange. The study concluded that while automotive firms in Turkey made efforts to emphasize intellectual capital components, financial assets remained the primary indicators affecting firm performance.

Gruian (2011): In his study, Gruian examined the impact of intellectual capital on firm performance using the VAIC model and regression analysis on 41 Romanian firms traded on the Bucharest Stock Exchange between 2007-2009. The results indicated a significant relationship between intellectual capital and business performance. The use of capital to generate added value effectively influenced firm performance, but when looking at individual components of intellectual capital, human and structural capital was not very effective for firms in Romania.

Chang and Hsieh (2011): Their study explored the role of innovation capital in creating value for business organizations. Using a modified version of the Value Added Intellectual Coefficient (VAIC) for 367 electronics firms in Taiwan between 2000-2008, they found that physical capital efficiency positively affected operational performance, and innovation capital impacted financial and market performance. The study also highlighted the significant role of intellectual property rights in value creation, emphasizing their importance for competitive advantages.

MTU - JBMS
Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi
Malatya Turgut Özal University Journal of Business and Management Sciences
ISSN: 2717-7890
Cilt/Volume:5, Sayı/Issue:2, Yıl/Year:2024, Sayfa/Page:202-242, ISSN: 2717-7890

Kendirli and Konak (2015): Their research investigated the impact of intellectual capital on firm performance among 12 companies registered in the BIST information index using market and accounting data from 2008-2012 analyzed through the Value-Added Intellectual Coefficient (VAIC) method with panel data analysis technique. The results showed a statistically significant and positive relationship between firm performance and efficiency variables and the used customer and human capital. Structural capital efficiency only significantly impacted the firms' asset turnover rates.

Verde, Castro, and Salvado (2016): Their research analyzed the link between intellectual capital and radical innovation in 251 mid-to-high technology firms operating in Spain through a survey. The findings indicated a linear relationship between human capital and radical innovation.

Kandil Göker (2017): The study investigated the impact of 11 IT firms' nine-year intellectual capital on their financial performance in Turkey using the Intellectual Capital Value Added Coefficient Method. Panel Data analysis was utilized to explore the effect of intellectual capital on firm performance. The results revealed that intellectual capital positively affected firms' asset profitability and equity returns. Additionally, the primary components of intellectual capital, human capital, and employed capital had a significant and positive effect on financial performance indicators. The study highlighted that intellectual capital positively influenced profitability in the IT sector.

Amin and Aslam (2017): Their research on pharmaceutical companies traded on the London Stock Exchange found that innovation capital was related to capital efficiency and significantly impacted the firm's financial performance.

Odabaşıoğlu (2018): His study used the intellectual capital value-added coefficient method to examine the financial performance indicators of 23 airline companies through panel data analysis. The results showed a statistically positive and meaningful relationship between dependent variables and components of intellectual capital. The analysis across all models suggested that physical capital was airline companies' most effective intellectual capital component.

Bayraktaroğlu, Çalışır, and Başkak (2019): Their study, using the VAIC model with additional new IC components (innovation capital and customer capital), investigated the effect of intellectual capital on firm performance in 400 manufacturing companies operating in the Turkish economy from 2003-2013 using multiple regression analysis. The adjusted VAIC value performed better on dependent variables, indicating that while innovation capital efficiency had no direct effect, structural capital efficiency (SCE) moderately impacted the relationship with dependent variables. The study also mentioned the direct effects of innovation capital efficiency on the total income to total assets book value ratio (ATO), a third financial performance indicator included in the study.

Xu and Li (2019): In their study, they used data from 116 high-tech SMEs and 380 non-high-tech SMEs listed on the Shenzhen Stock Exchange from 2012 to 2016 to test the effects of the four intellectual capital components—physical capital, human capital, structural capital, and relational capital—on financial performance using an extended Value-Added Intellectual Coefficient (MVAIC) model and multiple regression analysis. A significant difference in MVAIC

Cilt/Volume:5, Sayı/Issue:2, Yıl/Year:2024, Sayfa/Page:202-242, ISSN: 2717-7890

was observed between high-tech and non-high-tech SMEs. Additionally, a positive relationship was found between investment capital and financial performance in high-tech and non-high-tech SMEs. Specifically, intellectual capital was positively correlated with earnings, profitability, and business efficiency. Furthermore, capital employed efficiency, human capital efficiency, and structural capital efficiency were SMEs' most effective value drivers. In contrast, relational capital efficiency was found to be less critical.

Nancy, Sulistiawan, and Rudiawarni (2020): Their study analyzed the effect of intellectual capital components on firm performance for 552 firms operating in various sectors listed on the Indonesian Stock Exchange from 2014-2016 using regression analysis and the VAIC model. The study found that intellectual capital components positively impacted the five dimensions of firm performance: asset profitability, equity profitability, revenue growth, employee productivity, and market/book value. Intellectual capital was also found to affect future asset profitability positively. While the impact of human capital on asset profitability was very high in large-scale firms, it was lower in small-scale firms. R&D was more critical for small firms regarding intellectual capital than intangible assets.

Xu and Liu (2020): In their study, they added new IC components (innovation capital and relational capital) to the VAIC model and examined the effects of intellectual capital on the performance of 415 companies in the manufacturing sector of the South Korean economy from 2013 to 2018 using regression analysis. The study found that human capital was the IC component that most influenced profitability and efficiency. Structural capital did not significantly affect firm performance, while innovation and relational capital negatively affected firm profitability. The adjusted VAIC model performed better than the original VAIC model.

Innayah et al. (2021): Their study examined the effect of intellectual capital on bank performance using VAIC and panel regression analysis for 29 banks operating in Indonesia from 2014 to 2018. They also analyzed whether the presence of female managers strengthened the effect of intellectual capital on bank performance. The results showed efficient and effective use of intellectual capital led to higher bank performance. Additionally, it was found that female managers could enhance the impact of intellectual capital on performance.

Githaiga (2022): In his study, Githaiga examined the relationship between income diversification (generating income from multiple sources) and intellectual capital and bank performance for 53 East African banks from 2010 to 2018 using the VAIC method and panel data analysis. The study found that income diversification reduced the impact of intellectual capital efficiency on bank performance. However, different results were obtained for intellectual capital components. It was noted that income diversification increased the effect of structural capital efficiency on bank performance but decreased the impact of human capital efficiency.

Akgün and Türkoğlu (2023): Their study aimed to determine how much the financial performance success of 683 European firms that performed well during the global economic crisis depended on intellectual capital investments. The study used the VAIC method and panel data analysis. The research results indicated a positive relationship between intellectual capital, firm performance, and return on assets before the financial crisis but no return on equity and firm performance contribution to intellectual capital before and after the crisis.

Badri Shah and Ja'afar (2024): Their study analyzed the 2019-2021 data of 11 healthcare companies operating in Malaysia during the COVID-19 pandemic using the VAIC method and

MTU - JBMS
Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi
Malatya Turgut Özal University Journal of Business and Management Sciences
ISSN: 2717-7890
Cilt/Volume:5, Sayı/Issue:2, Yıl/Year:2024, Sayfa/Page:202-242, ISSN: 2717-7890

panel data analysis. The research found that value-added human capital and employed value-added capital had a significant and positive relationship with the dependent variable of return on equity. Human capital and employed capital were concluded to be the most efficient sources for generating profits and were vital components in the Malaysian healthcare sector's fight against the COVID-19 pandemic.

When the literature is reviewed, it is observed that researchers use similar and different variables to measure the relationship between intellectual capital and firm performance, conduct research in other sectors, and make comparisons by selecting firms from the same industry in different countries. Some studies have found positive and negative relationships between intellectual capital and firm performance. Researchers have also conducted studies based on intellectual capital components and obtained different results for each element. This study aims to examine the relationship between intellectual capital and firm performance by including innovation capital in the VAIC model. There are studies in the literature that have expanded the VAIC model by considering various influencing variables. However, this study will contribute to the literature by analyzing technology firms that use innovation capital extensively.

4. PURPOSE AND METHOD OF THE RESEARCH

This study aims to investigate the impact of intellectual capital on firm performance and determine how effectively IT firms utilize their intellectual capital through innovation investments. This section provides details on the data set and sample selection, the method used, and the variables that are in line with the purpose of the research.

4.1. Purpose of the Research

The purpose of this study is to re-evaluate the impact of firms' intellectual capital in the information technology sector listed on BIST on firm performance by including innovation capital. The study examines the contributions of the main components of intellectual capital—human capital, structural capital, and customer capital—to firm performance. Additionally, the intermediary role of innovation capital in this relationship, as well as how this capital alters and strengthens the interaction between intellectual capital and firm performance, has been analyzed. The study contributes to the existing literature by incorporating innovation capital. Moreover, it is significant in understanding the dynamics between intellectual capital and firm performance. The strategic importance of intellectual capital and innovation capital for sustaining the competitive advantage of firms in the information technology sector has also been emphasized.

4.2. Data Set and Sample of the Research

This study examined the financial data of three IT companies operating in Turkey whose stocks are traded on BIST. These three companies' accounting and economic data from 2010 to 2022 were used. Although 27 companies were listed in the technology index during the 12 years, only three companies were included due to the first limitation of the study: their financial statements provide information about innovation investments. The second limitation is that personnel expenses are considered a cost element rather than an investment in Turkey, and companies do not include personnel expenses in their balance sheets. The third limitation is that no companies from other countries were included in the study. If a study is conducted without including

MTU - JBMS
Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi
Malatya Turgut Özal University Journal of Business and Management Sciences
ISSN: 2717-7890
Cilt/Volume:5, Sayı/Issue:2, Yıl/Year:2024, Sayfa/Page:202-242, ISSN: 2717-7890

innovation investments in the model, more firms can be included in the analysis. Additionally, the number of firms included in the research can be increased by selecting firms operating in the information technology sector from different countries. The data for the companies were obtained from https://borsaistanbul.com/tr/ and https://www.kap.org.tr/en .In line with the limitations of the research, the following companies were included in the analysis:

- Netaş Bilişim Teknolojileri A.Ş.
- Alcatel Lucent Teletaş Telekomunikasyon A.Ş.
- Karel Elektronik Sanayi ve Ticaret A.Ş.

4.3. Research Method

After the importance of intellectual capital for companies was demonstrated, managers and researchers conducted various studies to express intellectual capital numerically. The first person to advocate that intellectual capital can be measured and included in companies' annual reports was L. Edvinson (Şamiloğlu, 2002:161). The fact that the elements of intellectual capital consist of intangible assets makes it difficult to express them monetarily. Despite the difficulty in measuring intangible assets, methods have been developed that express intellectual capital in monetary terms. One is the value-added intellectual coefficient (VAIC) method, developed by Ante Pulic in 1997. The fact that it is a method based on the financial data of companies, that it is based on concrete information that can be obtained without the need for detailed research and analysis, and that it helps determine the economic value of the intangible assets owned by companies and compare their investment performance with competitors constitute essential advantages of the VAIC method (Bayraktaroğlu et al., 2017:409; Öztürk and Demirgüneş, 1997: 62).

According to Pulic (2000), using accounting-based figures, the VAIC method measures and tracks the efficiency of value creation within a company. The better a company's resources (physical and intellectual capital) are utilized, the higher the efficiency of the company’s value creation (human capital). This, on the one hand, leads to an increase in value-added, while on the other hand, it helps determine the company's market value. Since VAIC uses accounting data, it focuses not on a company's costs but on the efficiency of the resources that create its value. The results are more comprehensive and reliable because VAIC is calculated based on information gathered from financial statements such as balance sheets and income statements (Pulic, 2000: 702). VAIC is composed of the sum of three capital efficiencies based on a company's financial statements: human capital efficiency (HCE), structural capital efficiency (SCE), and capital employed efficiency (CEE), and is represented as follows

VAIC = HCE + SCE + CEE

To calculate the efficiency levels of these three elements, the value-added (VA) created by the company must first be calculated. Value-added is defined as the difference between output and input. Here, output refers to the “total revenue obtained from all products and services sold in the market,” while input refers to “all expenses incurred by the company, excluding personnel costs.” The critical point of the method is that personnel expenses are not considered a cost because human capital plays an active role in the value-added creation process (Pulic, 2000: 706).

MTU - JBMS
Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi
Malatya Turgut Özal University Journal of Business and Management Sciences
ISSN: 2717-7890
Cilt/Volume:5, Sayı/Issue:2, Yıl/Year:2024, Sayfa/Page:202-242, ISSN: 2717-7890

VALUE ADDED (VA) = INPUT (S) - OUTPUT (B) = W + I + T + DP + NI
S: Net sales revenue
B: Cost of goods sold
W: Wages and salaries
I: Interest expenses
T: Taxes
DP: Depreciation
NI: Net profit after tax

Value-added can also be calculated using the following simplified equation (Ekim, 2017: 225):

VA = OP + EC + D + A
OP: Operating profit
EC: Employee costs
D: Depreciation expenses (for tangible assets)
A: Depletion and amortization (for intangible assets)

The next step in calculating added value is human capital efficiency (HCE). It is expressed as the ratio of value-added to human capital.

HCE = Value Added (VA) / Human Capital (HC)
HC: The total wages and salaries paid to the company's employees.

The third step is calculating Structural Capital Efficiency (SCE), obtained by subtracting human capital from value added.

Structural Capital (SC) = Value Added (VA) – Human Capital (HC)

The fourth step is to calculate Capital Employed Efficiency (CEE). It is expressed as the ratio of value-added to physical capital.

CEE = Value Added (VA) / Capital Employed (HC)
HC: The book value of the company's financial and physical resources.

In line with the research's objective, the fifth step is to include innovation capital as a variable in the VAIC calculation. In this context, Innovation Capital Efficiency (ICE) is calculated as follows. ICE is expressed by dividing research and development expenses by value-added.

ICE = R&D Expenses / Value Added (VA)

The extended VAIC is:

Extended VAIC = CEE + HCE + SCE + ICE

Finally, these four indicators constitute a company's intellectual capital competence (VAIC). Furthermore, a high VAIC value indicates a high company's intellectual capital performance (Pulic, Kolakovic, 2003:119).

Cilt/Volume:5, Sayı/Issue:2, Yıl/Year:2024, Sayfa/Page:202-242, ISSN: 2717-7890

4.3.1 Extended VAIC Model

In the literature, empirical evidence suggests that specific components considered to have been neglected by Pulic in the VAIC model should be included. In their study, Edvinsson and Malone (1997) included innovation capital and process capital; Bontis (2004) included innovation capital and process capital; Chen et al. (2005) included relational and innovation capital; Chang (2007) included capital and intellectual property capital; Huang and Liu (2005) included innovation capital; Chang and Hsieh (2011) included innovation capital; Bayraktaroğlu et al. (2019) included innovation and relational capital; Xu and Li (2019) included relational capital; Phusavat et al. (2011) included innovation capital; Ulum et al. (2014) included relational capital; and Nimtrakoon (2015) included relational capital. As seen from these studies, researchers have often included innovation and relational capital in the original VAIC model.

One of the main objectives of this research is to measure the investment in innovation by technology companies, which are managed to produce new products, improve existing products, develop new marketing strategies, establish new business models, and analyze their performance improvements. Therefore, innovation capital has been included in the VAIC model due to this study's selection of technology companies. Based on the studies above, the definition, calculation, and interpretation of innovation capital have been made.

Innovation capital is the ability to generate new knowledge based on previous knowledge. It represents the capital necessary to transform structural capital into value within the enterprise. In other words, a company must raise its R&D expenditures to the desired level to highlight the products, services, and technologies it produces. Companies focusing on R&D expenses can create value by utilizing structural capital knowledge (Bayraktaroğlu et al., 2019: 413; Xu and Liu, 2020: 162).

4.4. Research Hypotheses

Upon reviewing the literature, it has been found that there are numerous studies investigating the impact of intellectual capital on firm performance. The findings obtained by researchers generally suggest a positive relationship between intellectual capital and firm performance (Chen et al., 2005; Goh, 2005; Tan et al., 2007; Chu et al., 2011; Clarke et al., 2011; Rahman, 2012; Vishnu and Gupta, 2014; Nimtrakoon, 2015; Celenza and Rossi, 2014; Kendirli and Konak, 2015; Kandil Göker, 2017; Amin and Aslam, 2017; Odabaşoğlu, 2018; Xu and Li, 2019; Nancy, Sulistiawan, and Rudiawarni, 2020). Stewart (1997) also defined intellectual capital as an element that creates value for companies. Intellectual capital is seen as a strategic resource used by firms to gain a competitive advantage and enhance their financial performance (Chen et al., 2005; Goh, 2005; Clarke et al., 2011). Therefore, in the first group of hypotheses, the effectiveness of VAIC was investigated to determine whether there is a relationship between intellectual capital and firm performance.

When the literature was reviewed, many studies were found to have been conducted based on the components of intellectual capital. For example, HCE was found to have a significant impact on improving firm performance (Chan, 2009; Chen et al., 2005; Gan and Saleh, 2008; Maditinos et al., 2011; Tan et al., 2007), while SCE was found to have no significant relationship with firm performance (Clarke et al., 2011). Moreover, CEE was found to be positively related to firm performance (Chen et al., 2005; Clarke et al., 2011; Vishnu and Gupta, 2014; Zeghal and Maaloul,

MTU - JBMS
Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi
Malatya Turgut Özal University Journal of Business and Management Sciences
ISSN: 2717-7890
***Cilt/Volume**:5, **Sayı/Issue:**2, **Yıl/Year:**2024, **Sayfa/Page**:202-242, **ISSN:** 2717-7890*

2010; Joshi et al., 2013; Chu et al., 2011). Therefore, the second part of the study aims to investigate the effects of firm performance based on the components of intellectual capital

Intellectual capital is essential in improving a company's performance and other assets. In particular, in the information technology sector, which produces knowledge and technology-intensive products and services and contains more intellectual assets than financial and physical capital, intellectual capital can be seen as a strategic resource to enhance a company's performance and gain a competitive advantage. When examining studies conducted on information technology and technology companies in the literature, critical empirical studies such as Wang and Chang (2005), Huang and Liu (2005), Ng W. A. (2006), Kayalı et al. (2007), Kendirli and Konak (2015), Verde, Castro, and Salvado (2016), Kandil Göker (2017), and Xu and Li (2019) can be found. These studies have identified positive effects regarding companies' efficiency and intellectual capital elements.

The hypotheses of this study, which analyzes the effects of intellectual capital efficiency and intellectual capital components on firm performance based on analyses derived from companies' financial statements, are as follows:

a) Hypotheses Regarding Intellectual Capital Efficiency

H1: There is a relationship between return on assets (ROA) and intellectual capital efficiency.
ROA_{it}= α_{it}+β_1*$VAIC^{TM}{}_{it}$+β_2*$SIZE_{it}$+β_3*LEV_{it}+ε_{it}+β_4*PC+ε_{it} (1)

H2: There is a relationship between return on equity (ROE) and intellectual capital efficiency.
ROE_{it}= α_{it}+β_1*$VAIC^{TM}{}_{it}$+β_2*$SIZE_{it}$+β_3*LEV_{it}+ε_{it}+β_4*PC+ε_{it} (2)

H3: There is a relationship between earnings per share (EPS) and intellectual capital efficiency.
EPS_{it}= α_{it}+β_1*$VAIC^{TM}{}_{it}$+β_2*$SIZE_{it}$+β_3*LEV_{it}+ε_{it}+β_4*PC+ε_{it} (3)

H4: There is a relationship between price-to-book ratio (P/B) and intellectual capital efficiency.
P/B_{it}= α_{it}+β_1*$VAIC^{TM}{}_{it}$+β_2*$SIZE_{it}$+β_3*LEV_{it}+ε_{it}+β_4*PC+ε_{it} (4)

H5: There is a relationship between asset turnover ratio (ACS) and intellectual capital efficiency.
ACS_{it}= α_{it}+β_1*$VAIC^{TM}{}_{it}$+β_2*$SIZE_{it}$+β_3*LEV_{it}+ε_{it}+β_4*PC+ε_{it} (5)

H6: There is a relationship between value-added (VA) and intellectual capital efficiency.
VA_{it}= α_{it}+β_1*$VAIC^{TM}{}_{it}$+β_2*$SIZE_{it}$+β_3*LEV_{it}+ε_{it}+β_4*PC+ε_{it} (6)

b) Hypotheses Regarding the Efficiency of Intellectual Capital Components

H7: There is a relationship between return on assets (ROA) and the components of intellectual capital.

ROA_{it}= α_{it}+β_1*HCE_{it}+β_2*SCE_{it}+β_3*CEE_{it}+β_4*ICE_{it}+β_5*$SIZE_{it}$+β_6*LEV_{it}+ε_{it}+β_7*PC+ε_{it} (7)

H8: There is a relationship between return on equity (ROE) and the components of intellectual capital.

ROE_{it}= α_{it}+β_1*HCE_{it}+β_2*SCE_{it}+β_3*CEE_{it}+β_4*ICE_{it}+β_5*$SIZE_{it}$+β_6*LEV_{it}+ε_{it}+β_7*PC+ε_{it} (8)

MTU - JBMS
Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi
Malatya Turgut Özal University Journal of Business and Management Sciences
ISSN: 2717-7890
***Cilt/Volume**:5, **Sayı/Issue:**2, **Yıl/Year:**2024, **Sayfa/Page**:202-242, **ISSN:** 2717-7890*

H9: There is a relationship between earnings per share (EPS) and the components of intellectual capital.

$EPS_{it}= \alpha_{it}+\beta_1*HCE_{it}+\beta_2*SCE_{it}+\beta_3*CEE_{it}+\beta_4*ICE_{it}+\beta_5*SIZE_{it}+\beta_6*LEV_{it}+\varepsilon_{it}+\beta_7*PC+\varepsilon_{it}$ (9)

H10: There is a relationship between the price-to-book ratio (P/B) and the components of intellectual capital.

$P/B_{it}= \alpha_{it}+\beta_1*HCE_{it}+\beta_2*SCE_{it}+\beta_3*CEE_{it}+\beta_4*ICE_{it}+\beta_5*SIZE_{it}+\beta_6*LEV_{it}+\varepsilon_{it}+\beta_7*PC+\varepsilon_{it}$ (10)

H11: The asset turnover ratio (ACS) and the components of intellectual capital are related.

$ACS_{it}= \alpha_{it}+\beta_1*HCE_{it}+\beta_2*SCE_{it}+\beta_3*CEE_{it}+\beta_4*ICE_{it}+\beta_5*SIZE_{it}+\beta_6*LEV_{it}+\varepsilon_{it}+\beta_7*PC+\varepsilon_{it}$ (11)

H12: There is a relationship between value-added (VA) and the components of intellectual capital.

$VA_{it}= \alpha_{it}+\beta_1*HCE_{it}+\beta_2*SCE_{it}+\beta_3*CEE_{it}+\beta_4*ICE_{it}+\beta_5*SIZE_{it}+\beta_6*LEV_{it}+\varepsilon_{it}+\beta_7*PC+\varepsilon_{it}$ (12)

4.5. Dependent, Independent, and Control Variables

In this study, which investigates the explanation of the relationship level between intellectual capital and firm performance, the dependent variables were examined in terms of profitability, efficiency, and market valuation dimensions according to the VAIC method (Firer and Williams, 2003:351-352). For this reason, the most commonly used metrics in determining firm performance are Return on Assets (ROA), Return on Equity (ROE), Earnings Per Share (EPS), Market Value/Book Value Ratio (P/B), Asset Turnover (ACS), and Value Added (VA). The calculations for these ratios used to measure firm performance, were obtained from the financial statements published by the companies on the Public Disclosure Platform (PDP). The independent variables in the study consist of the VAIC method's components, representing intellectual capital's performance (Pulic, 1998). In line with the purpose of the study, Innovation Capital was added to the model alongside Human Capital, Structural Capital, and Customer Capital. Additionally, to isolate the contribution of intellectual capital to firms' financial performance and to minimize the effect of unknown variables, Financial Leverage Ratio, Firm Size, and Physical Capital Intensity were included in the model as control variables (Ekim, 2017, p. 227). All the variables included in the model are shown in Table 2.

Table 2: Dependent, Independent, and Control Variables

Variables	Definition	Calculation	Literature
	Dependent Variables		
ROA	Return on Assets	Net Profit / Total Assets	(Öztürk and Demirgüneş 1997; Firer and Williams, 2003; Demirgüneş, 2004; Huang, 2005; Kayalı et al 2007; Kendirli, 2015; Ekim, 2017; Kandil Göker, 2017; Bayraktaroğlu et al, 2018; Sulistiawan and Rudiawarni, 2020)

MTU - JBMS
Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi
Malatya Turgut Özal University Journal of Business and Management Sciences
ISSN: 2717-7890
Cilt/Volume:5, Sayı/Issue:2, Yıl/Year:2024, Sayfa/Page:202-242, ISSN: 2717-7890

ROE	Return on Equity	Net Profit / Total Equity	(Tan et al. (2007); Kendirli, 2015; Ekim, 2017; Kandil Göker, 2017; Bayraktaroğlu et al, 2018Odabaşoğlu, 2018; Sulistiawan and Rudiawarni, 2020)
EPS	Earnings Per Share		(Tan et al. (2007); Ekim, 2017)
P/B	Price-to-Book Ratio	Market Value / Book Value	(Öztürk and Demirgüneş 1997; Firer and Williams, 2003; Demirgüneş, 2004; Kayalı et al 2007; Kendirli, 2015; Bayraktaroğlu et al, 2018; Sulistiawan and Rudiawarni, 2020)
ACS	Asset Turnover Ratio	Revenue / Total Assets	(Öztürk and Demirgüneş 1997; Firer and Williams, 2003; Demirgüneş, 2004; Kayalı et al 2007; Kendirli, 2015; Bayraktaroğlu et al, 2018; Odabaşoğlu, 2018)
VA	Value Added	Interest Expenses + Depreciation + Dividends + Affiliate Earnings + Corporate Tax + Retained Earnings + Personnel Costs	(Demirgüneş, 2004; Goh, 2005)
		Control Variables	
LEV	Financial Leverage Ratio	Total Liabilities / Total Assets	(Öztürk and Demirgüneş 1997; Firer and Williams, 2003; Demirgüneş, 2004; Kayalı et al 2007; Kendirli, 2015; Kandil Göker, 2017; Ekim, 2017; Odabaşoğlu, 2018; Sulistiawan and Rudiawarni, 2020)
SİZE	Firm Size	Natural Logarithm of the Firm's Market Value	(Öztürk ve Demirgüneş 1997; Firer and Williams, 2003; Demirgüneş, 2004; Huang, 2005; Kayalı et al 2007; Kendirli, 2015; Verde et al, 2015; Ekim, 2017; Odabaşoğlu, 2018; Sulistiawan and Rudiawarni, 2020)
PC	Physical Capital Intensity	Fixed Assets / Total Assets	Ekim, 2017
		Independent Variables	
CEE	Capital Employed Efficiency	Value Added / Book Value of Assets	(Pulic, 1998)
HCE	Human Capital Efficiency	Value Added / Total Personnel Costs	(Pulic, 1998)
SCE	Structural Capital Efficiency	(Value Added - Human Capital Efficiency) / Value Added	(Pulic, 1998)

MTU - JBMS
Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi
Malatya Turgut Özal University Journal of Business and Management Sciences
ISSN: 2717-7890
Cilt/Volume:5, Sayı/Issue:2, Yıl/Year:2024, Sayfa/Page:202-242, ISSN: 2717-7890

ICE	Innovation Capital Efficiency	Research and Development Expenses / Value Added	(Huang, 2005; Chang, 2011; Verde et al, 2015; Bayraktaroğlu et al, 2018)
VAIC	Intellectual Capital Efficiency	CEE + HCE + SCE + ICE	(Pulic, 1998; Bayraktaroğlu et al, 2018)

5. FINDINGS OF THE STUDY

The relationship between intellectual capital efficiency, the components of intellectual capital, and the impact on firm performance was tested using panel data regression analysis. The study's empirical results were obtained using the Stata 14 software package.

5.1. Evaluation of Dependent and Control Variables in Terms of Intellectual Capital Efficiency

In panel data analysis, the regression model established was used to test for the presence of unit and time effects (F-test), to test the validity of the fixed effects model (LR test), and to test the validity of the random effects model (LM test) (Yerdelen Tataloğlu, 2018:35). According to the test results for the presence of unit and time effects, the H0 hypothesis could not be rejected for the ROE, EPS, and PB dependent variables, meaning that there were no unit and time effects. Therefore, the classical model will be preferred for these three regression models. For the ROA, ACS, and VA dependent variables, the H0 hypothesis was rejected in terms of unit effect but not rejected in terms of time effect. As a result, since the unit effect is present but the time effect is not, it was determined that the model is one-way and unit-effect-based.

Table 3: F, LR, and LM Unit and Time Effect Test Results

		ROA	ROE	EPS	PB	ACS	VA
μ, λ	F	P: 0.0001*** P: 0.7283	P: 0.0049** P: 0.0480	P: 0.0073** P: 0.4396	P: 0.0348** P: 0.5076	P: 0.0000*** P: 0.9628	P: 0.0050*** P: 0.2475
	LR	P: 0.0013*** P: 1.0000	P: 0.0551* P: 0.2219	P: 0.0863* P: 1.0000	P: 1.0000 P: 1.0000	P: 0.0000*** P: 1.0000	P: 0.0235** P: 0.4492
	LM	P: 1.0000 P: 1.0000	P: 1.0000 P: 0.2523	P:1.0000 P: 1.0000	P: 1.0000 P: 1.0000	P: 1.0000 P: 1.0000	P: 1.0000 P: 0.4541
Conclusion		Unit Effects Present No Time Effects	No Unit Effects No Time Effects	No Unit Effects No Time Effects	No Unit Effects No Time Effects	Unit Effects Present No Time Effects	Unit Effects Present No Time Effects
Model		One-Way Effects	Classical	Classical	Classical	One-Way Effects	One-Way Effects

10%*, 5%** and 1%*** indicate the significance level.

MTU - JBMS
Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi
Malatya Turgut Özal University Journal of Business and Management Sciences
ISSN: 2717-7890
Cilt/Volume:5, Sayı/Issue:2, Yıl/Year:2024, Sayfa/Page:202-242, ISSN: 2717-7890

The Hausman, Hausman sigmamore, and rHausman tests were used to choose between fixed and random effects for the dependent variables ROA, ACS, and VA, where a one-way unit effect is observed. The test results are provided below.

Table 4: Hausman, Sigmamore and rHausman Test Results

		ROA	ACS	VA
μ, λ	hausman	0.0000	0.9381	0.2574
	h.sigmamore	0.0007	0.0001	0.0083
	rhausman	0.0552	0.1203	0.3719
Conclusion		Fixed Effects Enabled	Random Effects Active	Random Effects Active

Before proceeding with regression analysis for dependent variables regarding intellectual capital effectiveness, it is necessary to check for deviations from assumptions after determining the panel data model. Deviations from assumptions in panel data models are listed as follows (Yerdelen Tatoğlu, 2018: 211-245):

- Deviation due to omitted variables (should not be a specification error)
- Normal distribution test (error terms should be normally distributed)
- Reduction of multicollinearity issues
- Error terms should be free from autocorrelation
- No heteroskedasticity problems
- Error terms should not be independent across units

Table 5: Results Regarding Deviations from Assumptions

	ROA	ROE	EPS	PB	ACS	VA
RESET Y RESET L RESET S	Reset L Reset S P-Value > %5	Reset L Reset S P-Value > %5	Reset L Reset S P-Value > %5	Reset L Reset S P-Value > %5	Reset L Reset S P-Value > %5	Reset L Reset S P-Value > %5
Jarque-Bera skewness and kurtosis	.2559	.2559	.2559	.2559	0.1516	0.1262
VIF	1.14	1.14	1.14	1.14	1.14	1.14
Durbin Watson ve Baltagi LBI **Wooldridge'n in (KM)**	D-W = 1.11873 Baltag LBI = 1.354	W: 0.2211	W:0.2467	W: 0.7098	D-W= 1.1278 Baltagi LBI = 1.369	D-W = 1.817 Baltagi LBI = 2.016

MTU - JBMS
Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi
Malatya Turgut Özal University Journal of Business and Management Sciences
ISSN: 2717-7890
***Cilt/Volume**:5, **Sayı/Issue:**2, **Yıl/Year:**2024, **Sayfa/Page**:202-242, **ISSN:** 2717-7890*

Modified Wald (SE) **Levene Brown ve Forsythe (TE)** **White (KM)**	MW: 0.0011	W: .0019	W: 8.7e-04	W: 3.8e-04	W0: 0.100 W50: 0.147 W10: 0.145	W0: 0.100 W50: 0.147 W10: 0.145
Pesaran	0.2552	-	-	-	0.6230	0.3682
Friedman	0.0073	-	-	-	0.0255	0.0009
Frees	Table value:0.2620 Calculated value:0.713	-	-	-	Table value:0.2620 Calculated value:0.109	Table value:0.2620 Calculated value:-0.180

Deviation due to omitted variables causes a correlation between the error term and the dependent variables. According to the results of the Regression Specification Error Tests (RESET) conducted for the dependent variables ROA, ROE, EPS, PB, ACS, and VA, there is no correlation between the error terms and the dependent variables, based on all RESET L and RESET S test results.

Since non-normal distribution of error terms can lead to inconsistent estimates, Jarque-Bera, skewness, and kurtosis tests were used to check if the error terms are normally distributed. The test results for the dependent variables ROA, ROE, EPS, PB, ACS, and VA indicate that the error terms are normally distributed.

Multicollinearity is the absence of relationships among the dependent variables in a regression model. It is measured by calculating the Variance Inflation Factor (VIF). A VIF value less than 5 indicates no relationship among the dependent variables. According to the VIF test results for the dependent variables ROA, ROE, EPS, PB, ACS, and VA, the VIF values are 1.14 < 5, indicating no multicollinearity.

Autocorrelation occurs when the terms are related to other periods' errors (Yerdelen Tatoğlu, 2018: 222-225). The presence of autocorrelation with fixed effects was tested using the Durbin-Watson and Baltagi-Wu tests. For the dependent variable ROA, the test statistic values shown in Table 3 are less than 2, indicating the presence of autocorrelation. Autocorrelation with random effects was tested using the Durbin-Watson and Baltagi-Wu tests. For the dependent variables ACS and VA, the test statistic values in Table 3 are less than 2, indicating the presence of autocorrelation. For the classical model, autocorrelation was tested using the Wooldridge test. Wooldridge proposed an autocorrelation test for panel data models with the null hypothesis H0:

***Cilt/Volume**:5, **Sayı/Issue:**2, **Yıl/Year:**2024, **Sayfa/Page**:202-242, **ISSN:** 2717-7890*

"no first-order autocorrelation" (Yerdelen Tatoğlu, 2018: 218). According to the test statistics for the dependent variables ROE and EPS in Table 3, which are less than 0.5, autocorrelation is present. For the dependent variable PB, the test statistics in Table 3 are more significant than 0.5, indicating no autocorrelation.

Heteroskedasticity refers to the assumption that the error term has a constant variance across all observations (Sümer, 2006: 18). The presence of heteroskedasticity with fixed effects was tested using the Modified Wald test. For the dependent variable ROA, the test statistic value in Table 3 is less than the 5% significance level, indicating heteroskedasticity. Thus, the null hypothesis H0 is rejected, and it is determined that the variance changes by unit. The presence of heteroskedasticity with random effects was tested using the Levene, Brown, and Forsythe tests. For the dependent variables ACS and VA, the test statistic values in Table 3 are more significant than the 5% significance level, indicating no heteroskedasticity. For the classical model, the test statistic values for the dependent variables ROE, EPS, and PB in Table 3 are less than 0.05, indicating the presence of heteroskedasticity.

One of the assumptions in the panel data model is that the error terms depend on the units. Pesaran, Friedman, and Frees tests were used to test inter-unit correlation. According to the Pesaran test, the test statistic values for the dependent variables ROA, ACS, and VA in Table 3 are more significant than the 5% significance level, indicating no inter-unit correlation. However, according to the Friedman and Frees test results, there is an inter-unit correlation based on the test statistic values in Table 3.

Based on the test results for deviations from assumptions for the dependent variables ROA, ROE, EPS, PB, ACS, and VA:

- There is no specification error.
- The error terms are normally distributed.
- There is no multicollinearity.

While heteroskedasticity exists for the dependent variables ROA, ROE, EPS, and PB, it is absent for ACS and VA. There is an autocorrelation issue for the dependent variables ROA, ROE, EPS, ACS, and VA. Inter-unit correlation is observed for the variables ROA, ACS, and VA. According to the results, if there is at least one of the issues of heteroskedasticity, autocorrelation, or inter-unit correlation in the model, either standard errors should be corrected without affecting parameter estimates, or appropriate methods should be used to make predictions in their presence (Yerdelen Tatoğlu, 2018: 251-252).

Table 6: Estimation Results for Final Models in Terms of Intellectual Capital Efficiency

		ROA	**ROE**	**EPS**	**PB**	**ACS**	**VA**
ldvaic	Prob	0.064*	0.055*	0.026**	0.913	0.813	0.111
	Coef.	.0534	.603	.847	.482	.0067	-6.89
llev	Prob	0.005***	0.010**	0.004**	0.013**	0.777	0.001***

MTU - JBMS
Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi
Malatya Turgut Özal University Journal of Business and Management Sciences
ISSN: 2717-7890
Cilt/Volume:5, *Sayı/Issue*:2, *Yıl/Year*:2024, *Sayfa/Page*:202-242, *ISSN*: 2717-7890

	Coef.	.02182	1.285	1.425	-23.42	-.0072	-1.46
lsize	Prob	0.005***	0.570	0.460	0.332	0.036**	0.000***
	Coef.	.0702	2.429	1.705	16.503	-.2123	1.09
lpc	Prob	0.513	0.177	0.840	0.640	0.034**	0.705
	Coef.	.0062	-0.695	-.085	.59356	-.21417	1.63
cons	Prob	0.005***	0.446	0.349	0.064*	0.009***	0.002***
	F	0.0000***	0.0070***	0.0005***	0.0000***	0.0004***	0.0000***
	R^2	0.4753	0.3321	0.4334	0.6641	0.3992	0.6959

10%*, 5%** and 1%*** indicate the significance level.

33% and 89%. The model with the highest R^2 value is where VA is the dependent variable, with an R^2 of 69%. This model explains 69% of the variability in the VA dependent variable with the dependent and control variables included in the model.

Table 7 provides an interpretation of the analysis results obtained in Table 6. It is observed that there is a positive relationship between firms' intellectual capital effectiveness and their return on assets, return on equity, and earnings per share. However, no relationship was found between intellectual capital effectiveness and market value/book value, asset turnover, and value-added.

According to the initial hypothesis, a relationship between return on assets and intellectual capital effectiveness was found. Hypothesis H1 is accepted. A positive relationship between firms' return on equity and intellectual capital effectiveness was identified. Hypothesis H2 is accepted. A positive relationship was observed between firms' earnings per share and intellectual capital effectiveness. Hypothesis H3 is accepted. No relationship was found between intellectual capital effectiveness and market value/book value, asset turnover, and value-added. Therefore, hypotheses H4, H5, and H6 are rejected.

Table 7: Intellectual Capital Efficiency and Firm Performance Results

ROA	• A 1% increase in firms' intellectual capital effectiveness results in a 0.053 unit increase in their return on assets. • A 1% increase in firms' size and financial leverage results in a 0.021 and 0.070 unit increase in return on assets, respectively. • No statistically significant relationship was observed between firms' physical capital intensity and return on assets.
ROE	• A 1% increase in firms' intellectual capital effectiveness results in a 0.603 unit increase in their return on equity. • A 1% increase in firms' financial leverage results in a 1.285 unit increase in return on equity. • No statistically significant relationship was observed between firms' size and physical capital intensity and return on equity.

MTU - JBMS
Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi
Malatya Turgut Özal University Journal of Business and Management Sciences
ISSN: 2717-7890
Cilt/Volume:5, Sayı/Issue:2, Yıl/Year:2024, Sayfa/Page:202-242, ISSN: 2717-7890

EPS	• A 1% increase in firms' intellectual capital effectiveness results in a 0.847 unit increase in earnings per share. • A 1% increase in firms' financial leverage results in a 1.425 unit increase in earnings per share. • No statistically significant relationship was observed between firms' size and physical capital intensity and earnings per share.
PB	• No statistically significant relationship was observed between firms' intellectual capital effectiveness and market value/book value. • A 1% increase in firms' financial leverage results in a 23.42 unit decrease in market value/book value. • No statistically significant relationship was observed between firms' size and physical capital intensity and market value/book value.
ACS	• No statistically significant relationship was observed between firms' intellectual capital effectiveness and asset turnover. • No statistically significant relationship was observed between firms' financial leverage and asset turnover. • A 1% increase in firms' size results in a 0.21 unit decrease in asset turnover. • A 1% increase in firms' physical capital intensity results in a 0.21 unit decrease in asset turnover.
VA	• No statistically significant relationship was observed between firms' intellectual capital effectiveness and value-added. • A 1% increase in firms' financial leverage results in a 1.46 unit decrease in value-added. • A 1% increase in firms' size results in a 1.09 unit increase in value-added. • No statistically significant relationship was observed between firms' physical capital intensity and value-added.

5.2. Evaluation of Dependent and Control Variables in Terms of Intellectual Capital Elements

This section of the study analyzes the effects of changes in intellectual capital elements on dependent and control variables. Initially, unit root and time effect tests were conducted for the variables in the study. Based on the results of these tests, the analysis includes tests for determining panel data models and examining deviations from assumptions.

Table 8: F, LR, and LM Unit and Time Effect Test Results

		ROA	ROE	EPS	PB	ACS	VA
μ, λ	F	P: 0.0001 P: 0.9707	P: 0.0049 P: 0.3080	P: 0.0457 P: 0.8039	P: 0.0027 P: 0.2016	P: 0.0000 P: 0.9098	P: 0.0010 P: 0.0002
	LR	P: 0.0003 P: 1.0000	P: 0.2787 P: 0.2391	P: 0.3190 P: 1.0000	P: 0.0169 P: 1.0000	P: 0.0000 P: 1.0000	P: 0.0030 P: 0.1311
	LM	P: 1.0000 P: 1.0000	P: 1.0000 P: 1.0000	P:1.0000 P: 1.0000	P: 1.0000 P: 1.0000	P: 1.0000 P: 1.0000	P: 1.0000 P: 1.0000

***Cilt/Volume**:5, **Sayı/Issue:**2, **Yıl/Year:**2024, **Sayfa/Page**:202-242, **ISSN:** 2717-7890*

Conclusion	Unit Effects Present No Time Effects	No Unit Effects No Time Effects	No Unit Effects No Time Effects	Unit Effects Present No Time Effects	Unit Effects Present No Time Effects	Unit Effects Present No Time Effects
Model	One-Way Effects	Classical	Classical	One-Way Effects	One-Way Effects	One-Way Effects

10%*, 5%** and 1%*** indicate the significance level.

The Hausman test, Hausman sigmamore test, and rHausman tests were used to choose between fixed effects and random effects for the dependent variables ROA, PB, ACS, and VA, where a one-way unit effect is observed. The test results are provided below.

Table 9: Hausman, Sigmamore and Rhausman Test Results

		ROA	PB	ACS	VA
μ, λ	hausman	0.0000	0.0092	0.0000	0.0000
	h.sigmamore	0.0007	0.0056	0.0001	0.0029
	rhausman	0.1230	0.0445	0.1212	0.0256
Conclusion		Fixed Effects Enabled	Fixed Effects Enabled	Fixed Effects Enabled	Fixed Effects Enabled

According to the Hausman test results, it was found that a fixed effects panel data model should be used for the dependent variables ROA, PB, ACS, and VA. Detailed information on checking deviations from assumptions before proceeding with regression analysis is discussed in the section above on analyzing intellectual capital effectiveness. Results related to deviations from assumptions regarding intellectual capital elements are presented in Table 10.

Table 10: Results Regarding Deviations from Assumptions

	ROA	ROE	EPS	PB	ACS	VA
RESET Y RESET L RESET S	Reset L Reset S P-Value > %5	Reset L Reset S P-Value > %5	Reset L Reset S P-Value > %5	Reset L Reset S P-Value > %5	Reset L Reset S P-Value > %5	Reset L Reset S P-Value > %5
Jarque-Bera skewness and kurtosis	.5895	.5895	. 5895	.5895	.5895	.5895
VIF	1.64	1.64	1.64	1.64	1.64	1.64

MTU - JBMS
Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi
Malatya Turgut Özal University Journal of Business and Management Sciences
ISSN: 2717-7890

***Cilt/Volume**:5, **Sayı/Issue:**2, **Yıl/Year:**2024, **Sayfa/Page**:202-242, **ISSN:** 2717-7890*

Durbin Watson ve Baltagi LBI Wooldridge ’nin (KM)	D-W = 1.594 Baltag LBI = 1.704	W: 0.005	W:0.0375	D-W = 2.017 Baltag LBI = 2.333	D-W= 1.668 Baltagi LBI = 1.867	D-W = 1.910 Baltagi LBI = 2.122
Modified Wald (SE) White (KM)	MW: 0.6806	W: .2949	W: .2949	WW: 0.0000	WW:7867	WW:0.028
Pesaran	0.1303	-	-	0.1388	0.8931	0.8787
Friedman	0.0272	-	-	0.0001	0.0007	0.0118
Frees	Table value:0.023 Calculated value:0.2620	-	-	Table value:0.537 Calculated value:0.2620	Table value:-0.035 Calculated value:0.2620	Table value:-0.048 Calculated value:0.2620

Due to the exclusion, which leads to correlations between dependent variables, the Regression Specification Error Tests (RESET) results for the dependent variables ROA, ROE, EPS, PB, ACS, and VA show no correlation between error terms and dependent variables based on all RESET L and RESET S test results.

Since the non-normality of error terms can lead to inconsistent predictions, the normality of error terms was checked using the Jarque-Bera, skewness, and kurtosis tests. The test results indicated that the error terms are normally distributed for the dependent variables ROA, ROE, EPS, PB, ACS, and VA.

Multicollinearity in a regression model means no correlation among the dependent variables. It is measured by calculating the Variance Inflation Factor (VIF). A VIF value less than 5 indicates no correlation among the dependent variables. For the dependent variables ROA, ROE, EPS, PB, ACS, and VA, VIF test results show that VIF values are $1.64 < 5$, indicating no multicollinearity.

When error terms are related to error terms from other periods, autocorrelation is present (Yerdelen Tatoğlu, 2018: 222-225). Autocorrelation presence according to fixed effects was tested using Durbin-Watson and Baltagi-Wu tests. For the dependent variables ROA, ACS, and VA, the test statistics values in Table 10 are less than 2, indicating the presence of autocorrelation. For the dependent variable PB, the test statistics values in Table 10 are more significant than 2, indicating no autocorrelation. According to the classical model, autocorrelation was tested using the Wooldridge test. Wooldridge proposed an autocorrelation test with the null hypothesis H0, stating "no first-order autocorrelation" for panel data models (Yerdelen Tatoğlu, 2018: 218). For the

***Cilt/Volume**:5, **Sayı/Issue:**2, **Yıl/Year:**2024, **Sayfa/Page**:202-242, **ISSN:** 2717-7890*

dependent variables ROE and EPS, the test statistics values in Table 10 are less than 0.5, indicating the presence of autocorrelation.

Heteroscedasticity assumes that the error term has a constant variance for all observations (Sümer, 2006:18). The presence of heteroscedasticity according to fixed effects was tested using the Modified Wald test. For the dependent variables ROA and ACS, the test statistics values in Table 10 are more significant than the 5% significance level, indicating no heteroscedasticity. For the dependent variables PB and VA, the test statistics values in Table 10 are less than the 5% significance level, indicating the presence of heteroscedasticity. According to the classical model, for the dependent variables ROE and EPS, the test statistics values in Table 3 are more significant than 0.05, indicating no heteroscedasticity.

Pesaran, Friedman, and Fress tests were used to test for inter-unit correlation. According to the Pesaran test, for the dependent variables ROA, PB, ACS, and VA, the test statistics values in Table 10 are more significant than the 5% significance level, indicating no inter-unit correlation. However, according to the Friedman and Fress test results, inter-unit correlation was found based on the test statistics values in Table 10.

Based on the test results for deviations from assumptions for the dependent variables ROA, ROE, EPS, PB, ACS, and VA:

- There is no specification error.
- Error terms are normally distributed.
- There is no multicollinearity.

Heteroscedasticity is present for the dependent variables ROA, ROE, EPS, ACS, and VA, whereas not for the PB dependent variable. There is an autocorrelation issue for the dependent variables ROA, ROE, EPS, ACS, and VA. There is an inter-unit correlation issue for the dependent variables ROA, PB, ACS, and VA. According to the results, if there is at least one heteroscedasticity, autocorrelation, or inter-unit correlation problem in the model, either standard errors should be adjusted without altering parameter estimates or appropriate methods should be used for predictions if they are present (Yerdelen Tatoğlu, 2018: 251-252).

Table 11: Estimation Results for Final Models in Terms of Effectiveness of Intellectual Capital Elements

		ROA	ROE	EPS	PB	ACS	VA
cee	Prob	0.000***	0.033**	0.000***	0.620	0.111	0.266
	Coef.	.0025	.1149	.0630	-.0594	-.002	.2361985
hce	Prob	0.001***	0.041**	0.000***	0.089*	0.271	0.217
	Coef.	.0037	.1127	.2107	.5906	-.0061	-6714261
sce	Prob	0.024**	0.407	0.064*	0.198	0.000***	0.010**

Cilt/Volume:5, *Sayı/Issue*:2, *Yıl/Year*:2024, *Sayfa/Page*:202-242, *ISSN*: 2717-7890

	Coef.	.1734	-1.916	-3.465	40.39	.6910	7.26e+08
ice	Prob	0.022**	0.099*	0.084*	0.005***	0.116	0.842
	Coef.	.00025	.0074	.00897	.1475	.0005	175593.7
llev	Prob	0.003***	0.013**	0.037**	0.000***	0.114	0.000***
	Coef.	.0221	1.233	1.424	-25.96	-.0350	-1.61e+08
lsize	Prob	0.946	0.683	0.128	0.003***	0.115	0.001***
	Coef.	.0027	.6651	2.165	27.139	-.1907	9.11e+08
lpc	Prob	0.012**	0.021**	0.123	0.616	0.002***	0.579
	Coef.	-.0153	-.5225	-.369	1.848	-.1201	-1.81e+07
cons	Prob	0.035**	0.211	0.204	0.002**	0.050**	0.000***
	F	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
	R^2	0.6555	0.7099	0.6517	0.7709	0.5775	0.7697

10%*, 5%** and 1%*** indicate the significance level.

The F-test indicates that all models are statistically significant. The R^2 values range from 57% to 77%. The model with the highest R^2 value has PB as the dependent variable, at 77%. For this model, the independent and control variables explain 77% of the variability in the PB dependent variable.

Table 12 provides an interpretation of the analysis results obtained in Table 11. Significant results have been found between intellectual capital components and firm performance.

A positive relationship exists between firms' physical capital, human capital, structural capital, and innovation capital efficiency levels and their active profitability. Hypothesis H7 has been accepted. A positive relationship exists between firms' physical capital, human capital, innovation capital efficiency levels, and their return on equity, but no relationship has been found with structural capital. Hypothesis H8 has been accepted except for the structural capital efficiency level. A positive relationship exists between firms' physical capital, human capital, innovation capital efficiency levels, and earnings per share, but a negative relationship exists with structural capital. Hypothesis H9 has been accepted. There is a positive relationship between firms' human capital and innovation capital efficiency levels and their market-to-book value ratio but no relationship between physical and structural capital efficiency levels. Hypothesis H10 has been partially accepted. A positive relationship exists between firms' structural capital efficiency levels and asset turnover ratios but no relationship with physical capital, human capital, and innovation capital efficiency levels. Hypothesis H11 has been accepted concerning the structural capital efficiency level. There is no relationship between firms' physical, human, structural, and innovation capital efficiency levels and value creation. Hypothesis H12 has been rejected.

***Cilt/Volume**:5, **Sayı/Issue:**2, **Yıl/Year:**2024, **Sayfa/Page**:202-242, **ISSN:** 2717-7890*

Table:12 Intellectual Capital Elements and Firm Performance Results

ROA	• A 1% increase in firms' physical capital efficiency levels leads to a 0.025 unit increase in their active profitability. This result is similar to the findings of Phusavat et al. (2011). • A 1% increase in firms' human capital efficiency levels leads to a 0.0037 unit increase in their active profitability. This result is similar to the findings of Xu and Li (2019), Xu and Liu (2020), Ahman and Sohn (2020), and Phusavat et al. (2011). • A 1% increase in firms' structural capital efficiency levels leads to a 0.1734 unit increase in their active profitability. This result is similar to the findings of Chang and Hsieh (2011), Xu and Li (2019), and Xu and Liu (2020). • A 1% increase in firms' innovation capital efficiency levels leads to a 0.00025 unit increase in their active profitability. This result is similar to the findings of Chang and Hsieh (2011) and Amin and Aslam (2017). • A 1% increase in firms' financial leverage results in a 1.233 unit increase in their active profitability. • No statistically significant relationship was observed between firms' size and active profitability. • A 1% increase in firms' physical capital intensity leads to a 0.0153 unit decrease in their active profitability.
ROE	• A 1% increase in firms' physical capital efficiency levels leads to a 0.1149 unit increase in their return on equity. This result is similar to the findings of Phusavat et al. (2011) and Chang and Hsieh (2011). • A 1% increase in firms' human capital efficiency levels leads to a 0.1127 unit increase in their return on equity. This result is similar to the findings of Phusavat et al. (2011) and Xu and Liu (2020). • No statistically significant relationship was found between firms' structural capital efficiency levels and return on equity. This result is similar to the findings of Phusavat et al. (2011). • A 1% increase in firms' innovation capital efficiency levels leads to a 0.0074 unit increase in their return on equity. This result is similar to the findings of Chang and Hsieh (2011) and Amin and Aslam (2017). • A 1% increase in firms' financial leverage results in a 1.285 unit increase in return on equity. • No statistically significant relationship was observed between firms' size and return on equity. • A 1% increase in firms' physical capital intensity leads to a 0.5225 unit decrease in their return on equity.
EPS	• A 1% increase in firms' physical capital efficiency levels leads to a 0.0630 unit increase in earnings per share. This result is similar to the findings of Chang and Hsieh (2011). • A 1% increase in firms' human capital efficiency levels leads to a 0.2107 unit increase in earnings per share. • A 1% increase in firms' structural capital efficiency levels leads to a 3.465 unit decrease in earnings per share. This result is similar to the findings of Chang and Hsieh (2011). • A 1% increase in firms' innovation capital efficiency levels leads to a 0.00897 unit increase in earnings per share. This result is similar to the findings of Chang and Hsieh (2011). • A 1% increase in firms' financial leverage results in a 1.424 unit increase in earnings per share. • No statistically significant relationship was observed between firms' size and physical capital intensity with earnings per share.
PB	• No statistically significant relationship was found between firms' physical capital efficiency levels and market-to-book value ratio. • A 1% increase in firms' human capital efficiency levels leads to a 0.5906 unit increase in market-to-book value ratio. This result is similar to the findings of Chen et al. (2005). • No statistically significant relationship was observed between firms' structural capital efficiency levels and market-to-book value ratio. • A 1% increase in firms' innovation capital efficiency levels leads to a 0.1475 unit increase in market-to-book value ratio. This result is similar to the findings of Sohn and Ahman (2020) and Amin and Aslam (2017). • A 1% increase in firms' financial leverage results in a 25.96 unit decrease in market-to-book value ratio. • A 1% increase in firms' size leads to a 27.139 unit increase in market-to-book value ratio.

MTU - JBMS
Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi
Malatya Turgut Özal University Journal of Business and Management Sciences
ISSN: 2717-7890
Cilt/Volume:5, Sayı/Issue:2, Yıl/Year:2024, Sayfa/Page:202-242, ISSN: 2717-7890

	• No statistically significant relationship was observed between firms' physical capital intensity and market-to-book value ratio.
ACS	• No statistically significant relationship was observed between firms' physical capital efficiency levels and asset turnover ratio. This result is similar to the findings of Sohn and Ahman (2020). • No statistically significant relationship was observed between firms' human capital efficiency levels and asset turnover ratio. • A 1% increase in firms' structural capital efficiency levels leads to a 0.6910 unit increase in asset turnover ratio. • No statistically significant relationship was observed between firms' innovation capital efficiency levels and asset turnover ratio. • No statistically significant relationship was observed between firms' financial leverage and asset turnover ratio. • No statistically significant relationship was observed between firms' size and asset turnover ratio. • A 1% increase in firms' physical capital intensity leads to a 0.1201 unit decrease in asset turnover ratio.
VA	• No statistically significant relationship was observed between firms' physical capital efficiency levels and value added. • No statistically significant relationship was observed between firms' human capital efficiency levels and value added. • No statistically significant relationship was observed between firms' structural capital efficiency levels and value added. • No statistically significant relationship was observed between firms' innovation capital efficiency levels and value added. • A 1% increase in firms' financial leverage leads to a 1.61 unit decrease in value added. • A 1% increase in firms' size leads to a 9.11 unit increase in value added. • No statistically significant relationship was observed between firms' physical capital intensity and value added.

6. DISCUSSION

In this section of the study, the findings obtained as a result of the study are evaluated by comparing them with the research results conducted by researchers in the literature.

Table: 13 Comparison of Research Findings with Literature

Model and Method Used: Extended VAIC, Panel regression
Source/Sample: Financial data of technology firms listed on BIST between 2010-2022
Research Findings: It has been observed that intellectual capital has an impact on firm value in terms of ROA, ROE, and EPS variables. The variables CEE, SCE, HCE, and ICE were found to positively affect ROA. The variables CEE, HCE, and ICE were observed to positively affect ROE.
CEE, HCE, and ICE were found to positively affect EPS, while SCE was found to negatively affect EPS. HCE and ICE were found to positively affect PB. SCE was observed to positively affect ACS and VA.

Author(s) / Year	Model and Method Used	Source / Sample	Research Findings	Comparison
Öztürk and Demirgüneş (1997)	VAIC; Çoklu Regresyon Analizi	30 manufacturing firms listed on the Istanbul Stock Exchange (ISE)	It has been observed that intellectual capital is not a sufficiently influential factor on firm value. A positive effect was found between the ROA and P/B variables and the CEE, SCE, and	Different sectors were considered. While the study identified a relationship between intellectual capital and firm performance, Öztürk and Demirgüneş (1997) found the opposite result. In

MTU - JBMS
Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi
Malatya Turgut Özal University Journal of Business and Management Sciences
ISSN: 2717-7890
Cilt/Volume:5, *Sayı/Issue:*2, *Yıl/Year:*2024, *Sayfa/Page*:202-242, *ISSN:* 2717-7890

		Period: 2000-2002	HCE variables. No effect was found between the ACS variable and the CEE, SCE, and HCE variables. Among the control variables, Size and Lev positively affected the PB values of the examined businesses, while ROE had a negative effect. It was observed that CEE and SCE negatively impacted the PB values of businesses, while HCE had a positive impact.	both studies, a positive effect was observed between the ROA variable and the CEE, SCE, and HCE variables.
Firer and Williams (2003)	VAIC; OLS Model Using Cross-Sectional Data	75 publicly traded companies from different sectors in South Africa (banking, electricity, information technology, services)	Positive relationship between SCE and ROA. Positive relationship between CEE and PB. Negative relationship between CEE and ACS. Negative relationship between HCE and ACS.	While Firer and Williams (2003) included companies from different sectors in their analysis, this study only analyzed the information technology sector. In Firer and Williams (2003), only the relationship between SCE and ROA was observed, whereas in this study, all components were found to be related. Firer and Williams (2003) found a positive relationship between CEE and PB, whereas no such relationship was observed in this study.
Chen et al. (2005)	VAIC; Pooled OLS Model	4254 firms from various sectors listed on the Taiwan Stock Exchange were analyzed.	They examined VAIC components both as a whole and by individual variables. It was found that intellectual capital had a positive effect on firm value. Innovation capital investments were found to have a positive impact on firm value and profitability. There is a positive relationship between CEE, SCE, HCE variables, and P/B.	This study found similar results to Chen et al. (2005), showing a positive effect of intellectual capital on firm value. Similar results were also obtained concerning innovation capital investments.
Gosh (2005)	VAIC and OLS model using cross-sectional data analysis.	16 (domestic and foreign) commercial banks in Malaysia during the 2001-2003 period.	All banks performed better in terms of human capital efficiency compared to structural and employed capital efficiencies. Local banks were generally found to be less efficient than foreign banks.	In Gosh (2005)'s study, HCE was found to be the most effective on firm value. However, in this study, all VAIC components were found to be effective on firm performance.
Tan et al. (2007)	VAIC; Pooled OLS Model	150 companies listed on the Singapore Stock Exchange between 2000-2002.	There is a positive relationship between VAIC and firm performance.	The result of this study is similar to that of Tan et al. (2007), which also found a

Cilt/Volume:5, ***Sayı/Issue***:2, ***Yıl/Year***:2024, ***Sayfa/Page***:202-242, ***ISSN***: 2717-7890

				positive relationship between VAIC and firm performance.
Gan and Saleh (2008)	VAIC; Pooled OLS Model	89 technology-intensive companies (MESDAQ) listed on the Malaysian Bursa stock exchange.	It was concluded that VAIC explains profitability and efficiency, but not market valuation	The sectors chosen in this study are similar to those selected in Gan and Saleh (2008)'s research sample. In both studies, the profitability components were found to explain VAIC. However, this study differs by showing that the HCE and ICE components positively affect PB.
Chan (2009)	VAIC; Pooled OLS Model	All companies listed in the Hang Seng Index of the Hong Kong Stock Exchange between 2001-2005.	No evidence was found to support a definitive relationship between intellectual capital, as measured by VAIC, and firm performance. Only a moderate relationship was found between intellectual capital and profitability metrics. There is a positive relationship between CEE and market value, as well as firm performance.	While this study found a positive relationship between VAIC and firm performance, such a relationship was not found in Chan (2009)'s research.
Zeghal and Maaloul (2010)	VAIC; Pooled OLS Model	300 UK companies from 2005 (technology, traditional, and service sectors).	VAIC and CEE show a positive relationship with ROA and PB	This result is similar to that of Zeghal and Maaloul (2010), which also found a positive relationship between VAIC and firm performance.
Maditinos et al. (2011)	VAIC; Pooled OLS Model	96 companies (from four different sectors) listed on the Athens Stock Exchange between 2006-2008.	It was found that there is a statistically significant relationship between human capital efficiency and financial performance.	Maditinos et al. (2011) found a relationship only between HCE and firm performance, whereas in this study, all VAIC components were found to have a positive impact on firm performance.
Chu et al.(2011)	VAIC; Pooled OLS Model	All companies listed in the Hang Seng Index of the Hong Kong Stock Exchange between 2001-2009.	It was found that intellectual capital, as measured by VAIC, showed a positive relationship with companies' profitability. Structural capital was found to play an important role in enhancing corporate profitability. The VAIC components positively affected the return on equity (ROE) and profitability variables. Capital efficiency (CEE) positively impacted ROA, ROE, ACS, and PB.	The result found by Chu et al. (2011), showing a positive relationship between intellectual capital and profitability, is similar to the findings of this study. In this study, SCE positively affected ROA, but had no effect on ROE, while in Chu et al. (2011), SCE positively affected both ROA and ROE. In this study, CEE positively affected ROA and ROE, while in Chu et al. (2011), CEE positively affected ROA, ROE, ACS, and PB.

MTU - JBMS
Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi
Malatya Turgut Özal University Journal of Business and Management Sciences
ISSN: 2717-7890
***Cilt/Volume**:5, **Sayı/Issue:**2, **Yıl/Year:**2024, **Sayfa/Page**:202-242, **ISSN:** 2717-7890*

Clarke et al.(2011)	VAIC; Pooled OLS Model	2004-2008, 2.161 companies from various sectors operating in Australia.	A positive relationship was found between VAIC and firm performance. It was concluded that among the VAIC components, HCE showed a stronger relationship, while CEE showed a weaker relationship, and SCE showed a very weak relationship.	The result of this study is similar to that of Clarke et al. (2011), which also found a positive relationship between VAIC and firm performance.
Celenza and Rossi (2014)	VAIC; Pooled OLS Model	23 companies listed in the Italian stock market between 2003-2008, with equity weights ranging from 33.87% to 41.38%.	They concluded that there is a positive relationship between changes in market value and changes in VAIC. A positive relationship was also found between VAIC and the dependent variables ROE (Return on Equity), ROS (Return on Sales), and ROI (Return on Investment).	While this study found that intellectual capital impacts firm value in terms of ROA, ROE, and EPS variables, Celenza and Rossi (2014) found a positive relationship between changes in market value and changes in VAIC.
Vishnu and Gupta (2014)	VAIC; Pooled OLS Model	22 pharmaceutical companies in India between 2005-2021.	VAIC shows a positive relationship with all measures of firm performance. While all components of the adjusted VAIC show a positive relationship with ROA, no relationship was found with SCE.	In Vishnu and Gupta (2014)'s study, the VAIC model was extended as in this study. While Vishnu and Gupta (2014) included relational capital in their model, this study included innovation capital in the model. The result of this study is similar to that of Vishnu and Gupta (2014), which also found a positive relationship between VAIC and firm performance.
Kendirli and Konak (2015)	VAIC and panel regression analysis	12 information technology companies listed on BIST between 2008-2012.	CEE and HCE positively affected ROA and ROE, while SCE positively affected ACS.	The sectors chosen in this study are the same as those selected by Kendirli and Konak (2015). The results of this study, showing that CEE and HCE positively affected ROA and ROE and that SCE positively affected ACS, are similar to those of Kendirli and Konak (2015).
Kandil Göker (2017)	VAIC and panel regression analysis	11 information technology companies listed on BIST between 2008-2016.	It was concluded that VAIC positively affected ROA and ROE. It was also found that HCE and CEE positively affected firm performance.	The sectors selected in this study are the same as those in Vishnu and Göker (2017). The result of this study, showing a positive relationship between VAIC and firm performance (ROE), is similar to that of Göker (2017).

***Cilt/Volume**:5, **Sayı/Issue:**2, **Yıl/Year:**2024, **Sayfa/Page**:202-242, **ISSN:** 2717-7890*

Amin and Aslam (2017)	VAIC: Structural Equation Modeling	207 pharmaceutical companies listed on the London Stock Exchange between 2012-2014.	It was concluded that intellectual capital and its components have a positive and significant effect on innovation and firms' financial performance. Additionally, innovation was also found to have a significant impact on firms' financial performance.	This result is similar to that of Amin and Aslam (2017), which also found a positive relationship between VAIC and firm performance. In this study, a positive relationship was found between innovation capital and ROA, ROE, EPS, and PB. Amin and Aslam (2017) also concluded that innovation had a significant impact on firms' financial performance.
Odabaşoğlu (2018)	VAIC; Pooled OLS Model	23 airline companies evaluated by Skytrax between 2007-2014.	It was found that there is a statistically positive and significant relationship between the dependent variables and the components of intellectual capital. The analysis results for all the models established in the study concluded that the most effective intellectual capital component in airline companies is physical capital.	In the study by Odabaşoğlu (2018), only ACS was one of the dependent variables included in this study to measure firm performance. In this study, structural capital was found to positively affect ACS.
Bayraktaroğlu, Çalışır, and Başkak (2019)	VAIC and panel regression analysis	400 manufacturing companies operating in Turkey between 2003-2013.	They added relational capital and innovation capital as independent variables to the VAIC model. Innovation capital efficiency (SCE) has a moderating effect on the relationship between ROA and ROE. SCE and CEE have a positive moderating effect on the relationship with profitability.	Bayraktaroğlu, Çalışır, and Başkak (2019) used the extended VAIC model in their study, as was done in this study. In both studies, innovation capital showed a positive relationship with ROA and ROE.
Xu and Li (2019)	VAIC and multiple regression analysis	116 high-tech SMEs and 380 non-high-tech SMEs listed on the Shenzhen Stock Exchange between 2012-2016.	They added relational capital as an independent variable to the VAIC model. Intellectual capital is positively related to firms' earnings, profitability, and operational efficiency.	Xu and Li (2019) used the extended VAIC model in their study, as was done in this study. In both studies, a positive relationship was found between VAIC components and ROA and ROE.
Nancy, Sulistiawan and Rudiawarni (2020)	VAIC and panel regression analysis	552 companies operating in various sectors and listed on the Indonesia Stock Exchange between 2014-2016.	The study concluded that the components of intellectual capital positively impacted five dimensions of firm performance (return on assets, return on equity,	In both studies, a positive effect was found between VAIC and the variables ROA, ROE, and PB.

Cilt/Volume:5, Sayı/Issue:2, Yıl/Year:2024, Sayfa/Page:202-242, ISSN: 2717-7890

			revenue growth, employee productivity, and market/book value).	
Xu and Liu (2020)	VAIC and panel regression analysis	415 companies operating in the manufacturing sector in South Korea between 2013-2018.	They added relational capital and innovation capital as independent variables to the VAIC model. It was found that HCE was the most influential variable on VAIC. Innovation capital and relational capital were found to have a negative impact on firm profitability.	Xu and Liu (2020) used the extended VAIC model in their study, as was done in this study. While this study found a positive relationship between ICE and the variables ROA, ROE, and PB, Xu and Liu (2020) found a negative relationship.
Akgün and Türkoğlu (2023)	VAIC and panel regression analysis	683 successful companies in Europe during the global financial crisis.	It was found that there was a positive relationship between intellectual capital and firm performance, as well as return on assets before the financial crisis. However, it was also found that return on equity and firm performance did not contribute to intellectual capital before or after the crisis.	The periods of this study differ from those in the study by Akgün and Türkoğlu (2023)..
Badri Shah and Ja'afar (2024)	VAIC and panel regression analysis	Data from 11 healthcare companies operating in Malaysia during the Covid-19 pandemic (2019-2021).	It was stated that value-added human capital and value-added employed capital had a significant and positive relationship with the dependent variable, return on equity (ROE).	In both studies, HCE and CEE were found to positively affect ROE.

7. CONCLUSION

Measuring the financial performance of businesses and determining their value has always been a significant concern for managers, investors, and financial institutions. As analyses of tangible assets alone were found to reflect the actual state of firms inadequately, there has been a shift toward including intangible assets in these analyses. With the transition from an industrial society to an information society, intellectual capital has become crucial for businesses. Especially in sectors reliant on information and technology, intangible assets have become more prominent than tangible ones. This indicates that the significant source of value for firms today is their intellectual capital, which includes knowledge, intellectual property, company culture, and customer relationships.

This study aims to determine the impact of intellectual capital and its components on firm performance. It selected firms in the information technology sector that report innovation

MTU - JBMS
Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi
Malatya Turgut Özal University Journal of Business and Management Sciences
ISSN: 2717-7890
***Cilt/Volume**:5, **Sayı/Issue:**2, **Yıl/Year:**2024, **Sayfa/Page**:202-242, **ISSN:** 2717-7890*

investments in their financial statements and included innovation capital as a component of intellectual capital. To identify firm performance, 12 models were created with dependent variables ROA, ROE, EPS, P/B, ACS, and VA, including intellectual capital and its components, as well as control variables LEV, SIZE, and PC.

The financial performance of three information technology firms listed on BIST, which reported innovation capital investments in their financial statements between 2010-2022, was analyzed using panel data analysis with the VAIC method developed by Ante Pulic. The final models were analyzed following selecting predictors and tests for deviation from assumptions. The study found that intellectual capital efficiency positively affects ROA, ROE, and EPS. Specific findings include:

- Physical capital efficiency, human capital efficiency, structural capital efficiency, and innovation capital efficiency positively impact ROA.
- Physical capital efficiency, human capital efficiency, and innovation capital efficiency positively impact ROE.
- Physical capital efficiency, human capital efficiency, and innovation capital efficiency positively affect EPS, while structural capital efficiency negatively impacts EPS.
- Human capital efficiency and innovation capital efficiency positively affect P/B.
- Structural capital efficiency positively affects ACS and VA.

According to the models established, the impact of return on assets, return on equity, and earnings per share on intellectual capital efficiency levels supports the hypothesis that intellectual capital leads to financial performance. This result is evidence that companies that can manage their resources effectively and efficiently and invest in their intellectual capital can achieve competitive advantage and create added value. In the analyses conducted on the components of intellectual capital, the positive impact, especially of human capital and innovation capital, on all dependent variables except ACS and VA aligns with the theory.

The limitations of the research include the inability to make economic comparisons due to the data set being obtained from a single country and the inclusion of only three companies in the analysis because many IT firms operating in the IT sector on BIST did not report R&D expenses. For future studies, it is recommended to include companies from different countries and to follow methods that allow comparisons between companies that prioritize R&D activities and those that do not, in order to reach more definitive results. Despite the mentioned limitations, significant findings have been obtained according to the research results. When the literature is reviewed, it is observed that the companies included in the scope of the research generally operate in developing countries. In the next study, analyzing companies operating in developed countries is anticipated to provide evidence in terms of making comparisons and revealing the power of the VAIC model to reflect the value of intellectual capital.

In conclusion, due to globalization, rapid technological advancements, and the information-based nature of the IT sector, intellectual capital investments are a crucial strategic factor for efficient and profitable operations. To achieve sustainable competitive advantage internationally, firms should transform into knowledge-intensive organizations, prioritize R&D activities, accelerate process renewal efforts, and focus on initiatives encouraging intellectual capital development.

MTU - JBMS
Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi
Malatya Turgut Özal University Journal of Business and Management Sciences
ISSN: 2717-7890
Cilt/Volume:*5*, ***Sayı/Issue:***2, ***Yıl/Year:***2024, ***Sayfa/Page***:*202-242*, ***ISSN:*** *2717-7890*

REFERENCES

Akgün, A. İ., & Türkoğlu, S. P. (2003). Intellectual capital and performance of listed firms during the global financial crisis: the effects of legal origin. *International Journal of Organizational Analysis, 32*(4), 759-785.

Amin, S., & Aslam, S. (2017). Intellectual Capital, Innovation and Firm Performance of Pharmaceuticals: A Study of the London Stock Exchange. *Journal of Information & Knowledge Management, 16*(2), 1750017/1-1750017/20.

Ante, P. (2000). VAIC™ – An accounting tool for IC management. *International Journal Technology Management, 5/6/7/8*(20), 702-714.

Badri Shah, N. S., & Ja'afar, R. (2024). Unveiling the Nexus Between Intellectual Capital Efficiency and Financial Performance in Malaysia's Healthcare Sector Amidst the Covid-19 Crisis. *Information Management and Business Review, 16*(1), 262-273.

Bayraktaroğlu, A. E., Çalışır, F., & Başkak, M. (2019). Intellectual capital and firm performance: an extended VAIC model. *Journal of Intellectual Capital, 20*(3), 406-425.

Bontis, N. (1998). Intellectual Capital: An Exploratory Study That Develops Measures and Models. *Management Decision, 36*(2), 63-76.

Bontis, N. (2002). Intellectual Capital Disclosure in Canadian Corporations. *Journal of Human Resource Costing & Accounting, 1*(1), 1-14.

Bontis, N. (2004). National Intellectual Capital Index: A United Nations Initiative For The Arab Region. *Journal of Intellectual Capital Journal of Intellectual Capital This journal doesn't have a profile on ResearchGate yet. Interested in this journal? Get notified when it activates its profile, and start getting updates. I'm interested, 5*(1), 13-39.

Brennan, N., & Connell, B. (2000). Intellectual Capital: Current Issues and Policy Implications. *Journal of Intellectual Capital, 1*(3), 206-240.

Castro, G.-d., & Verde, M. D. (2012). Assessing Knowledge Assets in Technology-Intensive Firms: Proposing a Model of Intellectual Capital. *Journal Of Centrum Cathedra*, 43-59.

Celenza , D., & Rossi, F. (2014). Intellectual capital and performance of listed companies: empirical evidence from Italy. *Measuring Business Excellence, 18*(1), 22-35.

Chan, K. H. (2009). Impact of intellectual capital on organisational performance. *The Learning Organization, 16*(1), 22-29.

Chang, S.-L., & Hsieh, J. (2011). Intellectual Capital And Value Creation Is Innovation Capital A Missing Link? *International Journal of Business and Management, 6*(2), 3-12.

Chen, M.-C., Cheng, S.-J., & Hwang, Y. (2005). An Empirical Investigation of the Relationship between Intellectual Capital and Firms' Market Value and Financial Performance. *Journal of Intellectual Capital Journal of Intellectual Capital This journal doesn't have a profile on ResearchGate yet. Interested in this journal? Get notified when it activates its profile, and start getting updates. I'm interested, 6*(2), 159-176.

MTU - JBMS
Malatya Turgut Özal Üniversitesi İşletme ve Yönetim Bilimleri Dergisi
Malatya Turgut Özal University Journal of Business and Management Sciences
ISSN: 2717-7890
Cilt/Volume:*5*, ***Sayı/Issue:***2, ***Yıl/Year:***2024, ***Sayfa/Page***:*202-242*, ***ISSN:*** *2717-7890*

Chen, M.-C., Cheng, S.-J., & Hwang, Y. (2005). An empirical investigation of therelationship between intellectualcapital and firms' market valueand financial performance. *Journal of Intellectual Capital, 6*(2), 159-176.

Choong, K. K. (2008). İntellectual Capital: Definitions, Categorization and Reporting Models. *Journal of Intellectual Capital, 4*(9), 609-638.

Chu, S. K., Chan, K., & Wu, W. (2011). Charting intellectual capital performance of the gateway to China". *Journal of Intellectual Capital, 12*(1), 249 - 276.

Clarke, M., Seng, D., & Whiting, R. (2011). Intellectual capital and firm performance in Australia. *Journal of Intellectual Capital, 12*(4), 505-530.

Edvinsson , L., & Malone , M. S. (1997). *ntellectual Capital: Realizing your Company's True Valueby Finding its Hidden Brainpower.* New York: Harper Business.

Edvinsson, L., & Malone, M. S. (1997). *Intellectual Capital: Realizing Your Company's True Value by Finding its Hidden Brainpower.* New York: Harper Business.

Ekim, N. (2017). Entelektüel Sermayenin Finans Sektöründe Değer Yaratmadaki Rolü: Türk Bankacılık Sektöründe Bir Araştırma. Doktora Tezi . *Selçuk Üniversitesi Sosyal Bilimler Üniversitesi*. Konya.

Ercan, M. K., Öztürk, B., & Demirgüneş, K. (2003). *Değere Dayalı Yönetim ve Entelektüel SErmaye.* Ankara: Gazi Kitapevi.

Firer, S. R., & Williams, M. (2003). Intellectual Capital and Traditional Measures of Corporate Performance. *Journal of Intellectual Capital, 4*(3), 348-360.

Gan, K., & Saleh, Z. (2008). Intellectual capital and corporate performance of technology-intensive companies: Malaysia evidence. *Asian Journal of Business and Accounting, 1*(1), 113-130.

Ghosh, D., & Wu, A. (2007). Intellectual Capital And Capital Markets: Additional Evidence. *Journal of Intellectual Capital, 2*(8), 216-235.

Githaiga, N. (2022). Intellectual capital and bank performance: the moderating role of income diversification. *sia-Pacific Journal of BusinessAdministration, 15*(4), 509-526.

Goh, C. P. (2005). Intellectual capital performance of commercial banks in Malaysia. *Journal of Intellectual Capital, 6*(3), 385-396.

Goh, P. C. (2005). Intellectual Capital Performance Of Commercial Banks İn Malaysia. *Journal of Intellectual Capital, 6*(3), 385-396.

Gruian, C. M. (2011). The Influence Of Intellectual Capıtal On Romanıan Companıes' Fınancıal Performance. *Annales Universitatis Apulensis Series Oeconomica,, 13*(2), 260-272.

Gu, F., & Lev, B. (2001). *Intangible assets – measurement, drivers, usefulness", working paper.* New York: Boston University and New York University,.

***Cilt/Volume**:5, **Sayı/Issue:**2, **Yıl/Year:**2024, **Sayfa/Page**:202-242, **ISSN:** 2717-7890*
Guthrie, J. (2022). The Management, Measurement And The Reporting Of İntellectual capital. *Journal of Intellectual Capital, 2*(1), 27-41.

Hall, R. (1992). The strategic analysis of intangible resources". *Strategic Management Journal, 13*(2), 135-144.

Huang, C. J., & Liu, C. J. (2005). Exploration For The Relationship Between İnnovation, IT And Performance. *Journal of Intellectual Capital, 2*(6), . 237-252.

İnnayah, M. N., Fuad, M., & Pratama, B. C. (2021). Intellectual capital and firm performance: The role of women directors. *Jurnal Akuntansi dan Pajak,, 24*(4), 142-150.

Itami, H. (1991). *Mobilizing Invisible Assets.* Cambridge: Harvard University Press,.

Kandil Göker, İ. E. (2017). Bilişim sektöründe Entelektüel Sermaye İle Finansal Performans İlişkisinin Belirlenmesine Yönelik Bir Araştırma. *International Journal of Academic Value Studies*, 78-86.

Karacan, S. (2004). Entelektüel Sermaye ve Yönetimi. *İSMMMO Yayın Organı Mali Çözüm Dergisi, 4*(69), 177-199.

Karacan, S. (2007). *Entelektüel Sermaye.* Ankara: Orient Yayınları.

Karacan, S., & Ergin, E. (2011). Bankaların Entelektüel Sermayesi ile Finansal Performansı Arasındaki İlişki. *Business and Economics Research Journal, 2*(4), 73-88.

Kaya, H. P. (2008). Entelektüel Sermayenin Finansal Tablolar Aracılığıyla Sunulması Sorunu ve Çözüm Önerileri. *Yayınlanmış Yüksek Lissans Tezi.* Sakarya Üniversitesi Sosyal Bilimler Enstitüsü.

Kayalı, C. A., Yereli, A. N., & Ada, Ş. (2007). Entelektüel Katma Değer Katsayısı Yöntemi Kullanılarak Entelektüel Sermayenin Firma Değeri Üzerindeki Etkisinin Belirlenmesine Yönelik Bir Araştırma. *Yönetim ve Ekonomi Dergisi, 14*(1), 67-90.

Kendirli, S., & Konak, F. (2015). Entelektüel Sermayenin Ölçülmesi ve Firma Performansı Üzerinde Etkisi: Borsa İstanbul'da İşlem Gören Bilişim Şirketleri Üzerine Bir Uygulama. *Sakarya İktisat Dergisi*, 31-51.

Lev, B. (2001). *ntangibles: Management, Measurement, and Reporting, The BrookingsInstitution.* Washington.

Maditinos, D., Chatzoudes, D., Tsairidis, C., & Theriou, G. (2011). The impact of intellectual capital on firms' market value and financial performance. *Journal of Intellectual Capital, 2*(1), 132-151.

Nancy, F., Sulistiawan, D., & Rudiawarni, F. (2020). Revisiting the Role of Intellectual Capital on Firms' Performance: Indonesian Evidence. *17th International Symposium on Management (INSYMA 2020). volume 115*, s. 350-355. Vietnam: Atlantis Press SARL.

Ng, A. (2006). Reporting intellectual capital flow in technology-based companies Case studies of Canadian Wireless Technology Companies. *Journal of Intellectual Capital*, 492-510.

Cilt/Volume:5, ***Sayı/Issue:***2, ***Yıl/Year:***2024, ***Sayfa/Page***:202-242, ***ISSN:*** 2717-7890

Nimtrakoon, S. (2015). The relationship between intellectual capital, firms' market value and financial performance: Empirical evidence from the ASEAN. *Journal of Intellectual Capital 1, 16*(3), 587-618.

Odabaşıoğlu, Ş. (2018). The Effect of Intellectual Capital on Financial Performance in the Context of Airline Companies. *International Journal of Social Science Research*, 211-237.

Oztürk, B. M., & Demirgüneş, K. (1997). Entellektüel Sermayenin Firma Değeri Üzerindeki Etkisinin Entellektüel Katma Değer Katsayısı Yöntemi ile Tespiti: Hisse Senetleri İMKB'de İşlem Gören Üretim Firmaları Üzerine Ampirik Bir Çalışma. *İMKB Dergisi, 10*(37), 59-80.

Pablos, P. (2002). Evidence of intellectual capital measurement from Asia, Europe and the Middle East. *Journal of Intellectual Capital, 3*(2), 287-302.

Pablos, P. O. (2003). Knowledge management projects: state of the art in the Spanish manufacturing industry. *Journal of Manufacturing Technology andManagement, 14*(4), 297-310.

Petty, R., & GUTHRİE, J. (2000). Intellectual Capital Literature Review. Measurement, Reporting and Management. *Journal of Intellectual Capital, 1*(2), 155-176.

Phusavat, K., Comepa, N., Sitko-Lutek, A., & Ooi, K.-B. (2011). Interrelationships Between Intellectual Capital And Performance. *Industrial Management & Data Systems, 111*(6), 810-829.

Pulic, A., & Kolakovic, M. (2003). Value Creation Efficiency In The New Economy. *Global Business and Economics Review, 5*(1), 111-128.

Sümer, K. K. (2006). White'ın Heteroskedisite Tutarlı Kovaryans Matrisi Tahmini Yoluyla Heteroskedasite Altında Model Tahmini. *İstanbul Üniversitesi İktisat Fakültesi Ekonometri ve İstatistik Dergisi*(4), 12-28.

Süral Özer, P., Özmen, Ö., & Saatçioğlu, Ö. (2004). Bilgi Yönetiminin Etkinliğine Kilit Bir Faktör Olarak Bilgi İşçileri ve İnsan Kaynakları Yönetiminin Farklılaşan Özellikleri. *Dokuz Eylül Üniversitesi Sosyal Bilimler enstitüsü Dergisi, 6*(1), 254-275.

Sohn, S. H., & Åhman, L. (2020). Impact of Intellectual Capital on Firm Performance and Market to Book Value - An analysis of the extended VAICTM model on Swedish listed firms within the healthcare sector. *Yüksek Lisans Tezi. University of Gothenburg School of Business, Economics and Law.*

Stewart, T. A., & Elhüseyini, Ç. N. (1997). *Entelektüel Sermaye: Kuruluşların Yeni Zenginliği.* İstanbul: Kontent Kitap.

Stewart, T. A., & Elhüseyni, N. (. (1997). *Entelektüel Sermaye: Kuruluşların Yeni Zenginliği.* İstanbul.: BZD yayıncılık.

Suzanne , H., & Sullivan, P. (2000). Profiting from intellectual capital – learning from leadingcompanies. *Journal of Intellectual Capital,, 1*(1), 33-46.

***Cilt/Volume**:5, **Sayı/Issue:**2, **Yıl/Year:**2024, **Sayfa/Page**:202-242, **ISSN:** 2717-7890*

Sveiby, K. E. (1997). *The New Organizational Wealth: Managing and Measuring Knowledge-basedAssets.* San Francisco,: Barrett-Kohler.

Tan, H. P., Plowman, D., & Hancock, P. (2007). Intellectual Capital and Financial Returns of Companies. *Journal of Intellectual Capital, 8*(1), 76-95.

Ulum, I., Gazali, İ., & Agus, P. (2014). Intellectual Capital Performance of Indonesian Banking Sector: A Modified VAIC (M-VAIC) Perspective. *Asian Journal of Finance & Accounting, 6*(2), 103-123.

Verde, M. D., Castro, G. M.-d., & Salvado, J. A. (2016). Intellectual capital and radical innovation: Exploring the quadratic effects in technology-based manufacturing firms. *Technovation*, 1-13.

Vishnu, S., & Gupta, K. V. (2014). Intellectual capital and performance of pharmaceutical firms in India. *Journal of Intellectual Capital, 15*(1), 83-99.

Wang, W.-Y., & Chang, C. (2005). Intellectual Capital Andperformance İn Causal Modelsevidence From The İnformation Technologyindustry İn Taiwan. *Journal of Intellectual Capital, 2*(6), 1469-1930.

Xu , J., & Li, J. (2019). The İmpact of İntellectual Capitalon SMEs' Performance in China Empirical Evidence Fromnon-High-Tech vs. High-Tech SMEs. *Journal of Intellectual Capital, 20*(4), 488-509.

Xu, J., & Liu, F. (2020). The Impact Of Intellectual Capıtal On Fırm Performance: A Modıfıed And Extended Vaıc Model. *Journal of Competitiveness, 12*(1), 161-176.

Yörük, N., & Erdem, M. (2008). Entelektüel Sermaye ve Unsurlarının, İMKB'de İşlem Gören Otomotiv Sektörü Firmalarının Finansal Performansı Üzerine Etkisi. *Atatürk Üniversitesi İİBF Dergisi, 22*(2), 397-413.

Yıldız, S. (2010). *Entelektüel Sermaye.* İstanbul: Türkmen Kitapevi.

Yerdelen Tatoğlu, F. (2018). *İleri Panel Veri Analizi/ Stata Uygulamalı.* İstanbul: Beta Yayıncılık.

Yumuşak, İ. G., & Özgür, A. (2007). Yeni Ekonominin İktisadi Etkileri ve İktisat Politikası Üzerine Yansımaları. *Bilgi Ekonomisi ve Yönetimi Dergisi, 2*(2), 18-55.

Zeghal, D., & Maaloul, A. (2010). Analysing value added as an indicator of intellectual capital and its consequences on company performance. *Journal of Intellectual Capital, 11*(1), 39-60.