

## BUSINESS INTELLIGENCE ON FIRM'S PERFORMANCE: THE MEDIATION EFFECTS OF OPEN INNOVATION AND FINANCIAL PERFORMANCE

DOI: 10.17261/Pressacademia.2023.1734  
RJBM- V.10-ISS.2-2023(1)-p.38-50

Mohsen Ejrami<sup>1</sup>, Nader Salehi<sup>2</sup>

<sup>1</sup>Islamic Azad University, Department of Management, Buin Zahra, Iran.

[mohsen.ejrami@yahoo.com](mailto:mohsen.ejrami@yahoo.com), ORCID: 0000-0002-1651-9830

<sup>2</sup>Islamic Azad University, Department of Management, E-Branch, Tehran, Iran.

[ndsalehi@gmail.com](mailto:ndsalehi@gmail.com), ORCID: 0000-0001-5424-1801

Date Received: December 12, 2022

Date Accepted: June 5, 2023



### To cite this document

Ejrami, M., Salehi, N., (2023). Business intelligence on firm's performance: The mediation effects of open innovation and financial performance. *Research Journal of Business and Management (RJBM)*, 10(2), 38-50.

Permanent link to this document: <http://doi.org/10.17261/Pressacademia.2023.1734>

Copyright: Published by PressAcademia and limited licensed re-use rights only.

### ABSTRACT

**Purpose-** In order to recognize and adapt to the changing demands and desires of their customers, businesses must become more inventive. This is made necessary by the quickly evolving multinational business environment and the extraordinary technological breakthroughs. Due to assure firm performance, these intelligence businesses must be able to respond to the complex dynamics in the global marketplace successfully, accurately, efficiently, and fast. Open innovation can be created to enhance performance by using knowledge learned about outside projects, rival businesses, clients, and new technologies. The purpose of this study is to ascertain the impact of business intelligence on a firm's performance with the mediation effect of open innovation on financial performance.

**Methodology-** The statistical population for this study consists of 200 managers from internet technology and software enterprises. There are 132 company managers in the sample. A questionnaire that was distributed and gathered using a non-probability sampling technique is the data collection tool in this study. The research data were also examined using Smart-PLS and SPSS software. In this study, both descriptive and inferential analyses were used.

**Findings-** Data analysis using PLS software and research findings demonstrate that business intelligence and open innovation have a positive influence on financial and firm performance. The findings also show that open innovation and financial performance play the roles of mediators.

**Conclusion-** The results demonstrate that higher business intelligence levels enhance firm performance. In today's fast-paced and competitive company world, managing and optimizing business performance is essential for maintaining viability as well as maximizing firm profitability. In order to access performance, effective business performance management will combine business analytics with open innovation. Business intelligence can therefore offer a foundation for comprehending which data is pertinent for open innovation and company business improvement.

**Keywords:** Business intelligence, firm performance, financial performance, open innovation

**JEL Codes:** M20, L25, O36

## 1. INTRODUCTION

The information age and globalization have ushered in the twenty-first century (Salehi et al., 2021). Due to the market rivalry the businesses must engage in inventive initiatives (Salehi and Asrar, 2022). Organizations and people are increasingly connected to one another and to other organizations (Orzan et al., 2020). To handle uncertainty, keep ahead of the crisis, and be ready for future issues, businesses must adopt new mindsets, approaches, and pragmatic solutions. Information that can be utilized as a foundation for intelligence practices is becoming more readily available through electronic means of collecting, processing, and communication, which is why business intelligence is gaining importance (Caseiro and Coelho, 2019). A new decision-support system called "business intelligence" is built on cutting-edge information technology and methodologies (Chen and Lin, 2019). In order to make effective decisions and increase economic value in the face of an ever-increasing abundance of data, businesses are increasingly turning to business intelligence (Božič and Dimovski, 2019). Business intelligence is crucial in today's organizations because it enables businesses to track market trends, rivals' moves, and customer behavior through delivering information (Huang et al., 2022). Although the word "business intelligence" is first

documented to have been used in 1865, the contemporary era of business intelligence began in the 1990s (Mariani et al., 2018). The development of computing and internet technologies has made it easier to continuously gather a significant volume of heterogeneous data from various sources, creating new opportunities and problems for business intelligence (Ram et al., 2016). In a business intelligence study, Choi et al. classified the suitability of social media data and compared that data to public government data and gray literature (Choi et al., 2020). Data is collected, stored, and evaluated by business intelligence, the procedural and technological infrastructure that enables a corporation to gather, store, and analyze data (Wang et al., 2022). There are new methods for assessing business intelligence data extraction tools and assisting users in creating well-organized, high-quality information for enterprises (Duque et al., 2022). Although business intelligence has been incorporated into firm plans, this field of study is still in its infancy. As a result, one of the objectives of this study was to examine how business intelligence affects performance while accounting for the effects of financial performance and innovation as mediators.

Due to globalization and increasing technical advancements, businesses now face more rivalry and market dynamism. Businesses must innovate to stay ahead of the competition (Božič and Dimovski, 2019). The idea of open innovations has made it possible to achieve and implement innovations for those organizations for which they were previously unattainable for a variety of reasons, as firms are continually seeking competitive advantage (Szromek et al., 2023). Open innovation refers to using a methodology for innovation that is susceptible to external contamination and involves the spreaders of new ideas (Bigliardi et al., 2023). The majority of innovative activities, such as enhancing internal invention processes and looking for outside commercialization opportunities, have been implemented by many businesses over many decades, therefore the origins of open innovation can be traced back a long way in time (Huizingh, 2011). Previous management studies have shown that open innovation at the business level aids in stimulating creativity by mixing expertise from various external partners, enriching a firm's internal knowledge base, and giving access to a wider range of technology opportunities (Bahemia and Roehrich, 2023). According to open innovation experts, companies can increase their resource base and become more innovative by interacting with actors outside of their organizational bounds and fusing their contributions with existing resources (Toroslu et al., 2023). Limitations of open innovation that are poorly documented in the literature lead to difficulties in open innovation implementation, complexity in open innovation governance, and ambiguity in open innovation outcomes (Abhari and McGuckin, 2023).

The firm has a duty to preserve sustainability and expansion in order to give investors hope of rewards. By carrying out activities in accordance with the wishes of investors, the company can continue to exist and investors can experience spectacular gains (Harahap et al., 2020). Marketing managers are under increasing pressure to defend their spending and demonstrate how it affects financial results practically (Narteh, 2018). Entrepreneurs can enhance financial performance, particularly when integrating resources in novel and distinctive ways to outperform rivals (Huang et al., 2022). While regularly assessing their wide range of operations and processes, many businesses employ financial performance measures. The attention must go beyond the confines of businesses when these procedures are connected to external organizations, creating an inter-organizational management and network accounting system (Seiler et al., 2020). Businesses need to be able to evaluate new circular offerings' financial performance, including the effects on costs, revenues, and cash flows (Kanzari et al., 2022). Financial statement analysis also makes it possible for financial markets to effectively allocate resources in accordance with the investor's wise choices (Mushtaq et al., 2022). Due to their complex structure and the lack of standardized research tools, few studies have examined the textual data from the financial statements to forecast the financial success of the companies.

A company's ability to improve business performance determines its success (Shanak et al., 2022). Consistently enhancing business procedures is crucial in the competitive and difficult business environment of today (Park and Song, 2020). Due to the limitations of traditional management of business performance based mostly on financial management, new non-traditional measures are now being advocated globally (Zamecnik and Rajnoha, 2015). The purpose of this study is to ascertain the impact of business intelligence on a firm's performance with the mediation effect of open innovation on financial performance. This issue demonstrates how business intelligence and open innovation can influence performance. In fact, nowadays, performance is brought and created by business intelligence through open innovation

The purpose of this research is to assess the impact of business intelligence on a firm's performance through the mediation effects of open innovation and financial performance. Research shows that business intelligence is the source of progress and growth in organizational performance that fosters open innovation. Also, the background of the research shows that the performance of the company relies on its financial performance, which is provided by achieving open innovation. The following section presents a review of key related literature, and hypotheses development.

## 2. LITERATURE REVIEW

### 2.1. Firm's Performance

According to Narteh (2018), a firm's performance is measured by its profitability, ability to lower investment risk, and ability to outperform its rivals. While retaining a dominant position in an industry, a corporation might spend in R&D operations, adopt new technologies, produce new goods, and other strategies to boost its firm performance (Tseng et al., 2023). Finding the factors that influence how well a corporation performs is a difficult undertaking (Chang and Li, 2019).

In order to innovate and run day-to-day operations more efficiently, managers must take on more complex hybrid ambidextrous tasks (Ali et al., 2020). Businesses that wish to perform better, expand, or gain a competitive advantage must innovate their business models (Bashir et al., 2023). It is thought that businesses can gain a competitive edge through learning and innovation processes, which eventually results in improved firm performance (Thoumrungroje and Racela, 2022).

Businesses must make an effort to obtain data to help management make better decisions that will enhance the success of the company (Caseiro and Coelho, 2019). Generally speaking, business intelligence systems are software programs that provide information to decision-makers to support the maintenance of business performance (Richards et al., 2019). Business intelligence plays an essential role in enhancing coordination among stakeholders and has a direct impact on operating efficiency and performance. It is an endogenous driving factor and an interactive force (Chen and Lin, 2021). Aspects of financial or non-financial nature may be covered by objective or subjective performance measurement (Kanzari et al., 2022). An important factor in determining a company's potential to thrive and expand is the analysis of its financial performance (Battisti et al., 2022).

### 2.2. Business Intelligence

The idea of business intelligence is not new, and many businesses and other organizations have used it (Suša Vugec et al., 2020). Throughout the last few decades, there has been a significant increase in the amount of information that is readily available, the speed at which business information is developing, and technological understanding (Salehi et al., 2013). Due to the inclusion of ideas like analytics, big data, and artificial intelligence—essential concepts for business executives in organizations of all sizes and industries, as well as in the public sector—it has recently gained even greater popularity (Suša Vugec et al., 2020). In order to help an organisation better understand its business and market and make timely business choices, business intelligence is the strategies, technologies, systems, practices, methodologies, and applications that analyze crucial business data (Božič and Dimovski, 2019). With the aim of assisting firms by facilitating knowledge and promoting better management decisions, business intelligence encompasses a variety of unique fields and technology (Moro et al., 2015). According to Huang et al. (2022), business intelligence is a priceless and irreplaceable internal resource that businesses use to increase their managers' knowledge bases (Huang et al., 2022). Business intelligence systems deal with and evaluate business data in a certain application field from a different industry using the data warehouse, online analysis, and data mining technologies (Zhang et al., 2022).

The amount of data that is gathered during an organization's everyday operations in its various departments and the information that managers need to know differs significantly (Xu et al., 2022). In order to make precise and wise business decisions as quickly as possible, business intelligence has been offered as a tool, product, and system, encompassing applications and analytics based on operational and analytical databases (Wang et al., 2022). Business intelligence, in its traditional sense, refers to a variety of organizational and technical tools that enable the conversion of massive amounts of real-time data into knowledge that can be used to decision-making processes.

It is asserted that business intelligence played a unique role when managers were required to perform the following tasks: (a) consider numerous data points in the decision-making process, frequently from different sources; (b) manage historical data; (c) manipulate synthetic data; (d) forecast the future and develop long-term plans; (f) conduct continuous control over the implementation of actions taken, both operational and strategic in nature; and (g) react quickly to changing circumstances (Olszak, 2022). Business intelligence aids a business in achieving its strategic objectives, responding to a variety of internal and external events that have an impact on daily operations, and planning for upcoming events (Binzafrah and Taleedi, 2022). Business intelligence can be used in a variety of ways, such as for product pricing determination, product placement, or sales forecasting (Nurdin et al., 2023). Success in business intelligence requires complexity, and complexity has a price. Business intelligence technology investments are costly since they require infrastructure, software, licenses, training, and wages for implementation (Gaardboe et al., 2017).

The business unit level is where business intelligence is thought to be most effective, and it is via improvements at the business unit level that overall organizational performance is improved (Peters et al., 2016). A thorough business intelligence system for marketing procedures needs precise and pertinent market data (Huang et al., 2022). Businesses can succeed in

building market value and enhancing financial performance, particularly when integrating resources in novel and unconventional ways to outperform rivals (Huang et al., 2022). As a result, the following hypotheses are proposed:

*H<sub>1</sub>: A higher level of business intelligence positively influences the development of open innovation.*

*H<sub>2</sub>: A higher level of business intelligence positively influences the development of financial performance.*

*H<sub>3</sub>: A higher level of business intelligence positively influences the development of a firm's performance.*

### 2.3. Financial Performance

The company's financial performance, including its sales and profitability growth, stock status and growth rate, net profit margin, and operating profit margin (Huang et al., 2022). Financial performance includes both market returns and the accounting rate of return, which measures the business's profits in relation to its invested assets (Rao and Vinod, 2023). The utilization of technology-based science and technology supported by skilled human resources to enable enhanced business productivity and economic stability is intimately tied to the financial performance of a corporation (Menne et al., 2022). Organizational and environmental strategies, technological capability, capital structure, comprehensive quality management, social responsibility, and R&D investment, as well as social, institutional, and market actors, are all factors that affect financial success (Wu and Huang, 2022).

Decision-makers, including managers, can utilize the information from financial performance review to assess the past and set objectives for the future (Türegün, 2022). The companies' decision-makers may find the financial performance to be a valuable source of information on the effectiveness of money flow (Liu et al., 2023). Businesses that maintain a steady flow of consumers who use their services are businesses that are successful financially (Narteh, 2018). The capacity to make profits will also rise if the financial performance is improving. The profitability ratio, which demonstrates the company's great capacity to produce returns for investors, demonstrates this (Nafasati and Hilal, 2021).

Financial performance can be understood as the outcomes of numerous operations that have been carried out, and it serves as an example of the company's success (Manurung et al., 2019). Nonetheless, business intelligence is crucial in today's enterprises because it gives them the opportunity to track market trends, the moves of rivals, and the behavior of customers (Huang et al., 2022). It is crucial to research how business intelligence affects financial performance. As a result, the following hypotheses are proposed:

*H<sub>4</sub>: A higher level of financial performance positively influences the development of a firm's performance.*

*H<sub>5</sub>: Financial performance mediates the effect between business intelligence and a firm's performance.*

*H<sub>6</sub>: Financial performance mediates the effects between open innovation and a firm's performance.*

### 2.4. Open Innovation

The competitive strategy of small, medium, and large firms must include innovation (Drucker, 2002; Salehi and Asrar, 2022). In keeping with the organization's business model, open innovation is a dispersed innovation process based on intentionally controlled knowledge flows across organizational boundaries (Lu and Chesbrough, 2022). The importance and relevance of collaboration between organizations and stakeholders in its many configurations in the process and development of innovation serves as the cornerstone of the aforementioned innovation category (Da Silva Meireles et al., 2022). The majority of research on open innovation have underlined the value of being broadly open to various outside sources of knowledge in enhancing innovation performance at the firm level (Bahemia and Roehrich, 2023).

The open innovation model's implementation necessitates a considerable organizational transformation within the business, affecting both current business procedures and its values or culture (Trzeciak et al., 2022). The closed innovation paradigm has been weakened by a number of variables, including the expanding mobility of skilled labor, the expansion of venture capital, and the increasing importance of outside knowledge suppliers (Ogink et al., 2022). Open innovation can be categorized into three main categories. IP in-licensing, concept and start-up competitions, and crowdsourcing are typical instances of inbound (outside-in) open innovation activities, whereas spin-offs and corporate business incubation are examples of outbound (inside-out) activities (Liu et al., 2022).

Inbound open innovation, also known as open innovation from the outside, is crucial for a firm's innovative performance as well as its financial success, according to the growing body of open innovation research (Cheah et al., 2021). Using their strong technical and economic capabilities, companies with plenty of resources can carry out their innovative internal actions (Moradi et al., 2021). It is possible to develop new goods or streamline processes by using the information learned about competitors, clients, and emerging technology. Hence, business intelligence fosters innovation inside the company (Eidzadeh et al., 2017). As a result, the following hypotheses are proposed:

H<sub>7</sub>: A higher level of open innovation positively influences the development of financial performance.

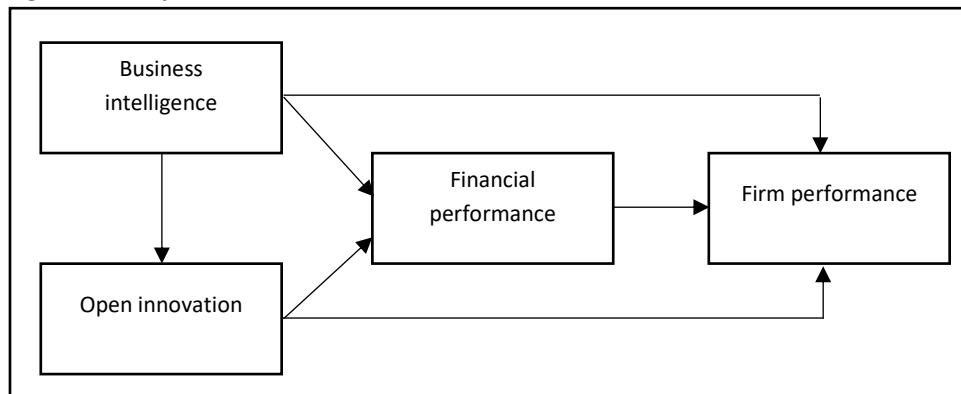
H<sub>8</sub>: A higher level of open innovation positively influences the development of a firm's performance.

H<sub>9</sub>: Open innovation mediates the effects of business intelligence on financial performance.

**3. DATA AND METHODOLOGY**

The statistical population of this research consists of 200 managers of internet technology and software companies. 132 firm managers have been chosen as the sample size using a non-probability sampling technique. The managers of these organizations evaluate the skills of the firms through the responses to the questionnaire. The conceptual model shown in Figure 1 is based on past research.

**Figure 1: Conceptual Model**



The statistical population of this research consists of 200 managers of internet technology and software companies. 132 firm managers have been chosen as the sample size in this regard using a non-probability sampling technique. The managers of these organizations were given and collected the study questionnaire in order to evaluate the skills of the firm and the responses.

The model's measurement indicators are given in this study. The measurement indices for the variables in the conceptual model are displayed in Table 1.

**Table 1: Measurement Indicators**

Variables	Measurement indicators	References
Business intelligence	Programs for business intelligence and analysis boost performance effectiveness and efficiency.	Bany Mohammad et al (2022)
	Programs for business intelligence and analysis are made to manage administrative and financial procedures and events.	
	With the utilization of the data kept in databases, business intelligence and analysis applications help firms make better decisions.	
	Programs for business intelligence and analysis assist in learning about the reality of databases stored in systems in areas that support the abilities of the organization's upper management.	
	Programs for business intelligence and analysis aim to improve the bank's capacity to complete all necessary objectives.	
	Programs for business intelligence and analysis display symbolic knowledge, such as graphs, semantic networks, and texts, in a straightforward manner.	
	Programs used for corporate intelligence and analysis can extract knowledge from complicated data.	
	Software for business intelligence and analysis enables quick and sufficient knowledge archiving.	
	The business intelligence and analysis programs represent the knowledge and inferences in accordance with the criteria established by the bank.	

Variables	Measurement indicators	References
	Programs for business intelligence and analysis use knowledge and inferences, which are kept secure to prevent manipulation.	
	Programs for business intelligence and analysis meet all the bank's information and data needs about banking operations.	
	The bank's business intelligence and software systems are aiming to update themselves regularly and automatically.	
	Systems and software for business intelligence and analysis handle logical and programming faults.	
	In the case of an unexpected outage in the bank's network, business intelligence and analysis software keep a copy of the data on hand automatically.	
	Periodic device maintenance is carried out by specialized organizations for the bank's business intelligence and analysis programs.	
	The programs connected to the bank's business intelligence and analytical tools are updated on a regular basis by specialized organizations.	
<b>Firm performance</b>		
<b>Operational efficiency</b>	Operating income, net	
	Margin of operations (Earnings before interest, taxes, depreciation, and amortization)	
	a profit-and-loss statement	
<b>Market effectiveness</b>		
	Sales Earnings	
	Market Shares	
	Asset Turnover	
	Integrated Reporting	
<b>Financial resilience</b>		
	Debt/ equity	
	Liquidity	
	Bankruptcy	
<b>Financial performance</b>		
	Increased profitability	
	Decrease in investment risk	
	Lowering of access barriers	
	Surpassing the competition	
	Reduction of costs	
	increased revenue	
<b>Open innovation</b>		
	Collaborated with a wide variety of external partners in industry in the last 3 years.	
	Collaborated very strongly with universities and research centers in the last 3 years.	
	Collaborated very strongly with technical and scientific service companies in the last 3 years.	
	Collaborated very strongly with governmental institutions in the last 3 years.	
	Collaborated very strongly with customers in the last 3 years.	
	Collaborated very strongly with firms operating in different sectors of activities in the last 3 years.	
	Collaborated very strongly with other competitors in the last 3 years.	
	Collaborated very strongly with suppliers in industry in the last 3 years.	
	A significant percent of sales of open innovation in the last 3 years.	
	Compared with major competitors, the introduced more open innovation offerings in the last 3 years.	

Mouzas and Bauer (2022)

Huang et al (2022); Gök and Peker (2017)

Gassmann et al. (2010); Lazzarotti et al. (2010)

Variables	Measurement indicators	References
	Even without using external technology, achievement market success in the last 3 years.	

The data in this study have been analyzed using descriptive and inferential tests. In the descriptive section, percentages, averages, and standard deviation were computed; in the inferential section, the study data were examined using SPSS and Smart PLS software. In two steps, the PLS model is evaluated and interpreted. two models: a structural model and a measurement model. By figuring out how the latent variables or sub-constructs are assessed in the form of a greater number of observable variables, the measurement model, which is a component of the confirmatory factor analysis, aids in addressing concerns about the validity and reliability of the measurement. The links between structures (latent variables) and their capacity for explanation are also displayed by the structural model.

#### 4. FINDINGS AND DISCUSSIONS

##### 4.1. Factor Loading Test

Table displays the weight values for the factor loadings in this questionnaire (2). The weight of factor loading for all questions is more than 0.7, as shown in the table below, which is the least value that can be used for factor loading. This leads to the conclusion that the questions chosen to assess each variable have the proper weight to assess that particular variable.

**Table 2: Values of Factor Loads**

Items	Business intelligence	Open innovation	Financial performance	Firm performance
Buln1	0.862217			
Buln2	0.806023			
Buln3	0.818976			
Buln4	0.841188			
Buln5	0.819507			
Buln6	0.806761			
Buln7	0.827478			
Buln8	0.908836			
Buln9	0.885312			
Buln10	0.834146			
Buln11	0.725922			
Buln12	0.976624			
Buln13	0.790273			
Buln14	0.775686			
Buln15	0.827246			
Buln16	0.755340			
FiPe1		0.966219		
FiPe2		0.805025		
FiPe3		0.814978		
FiPe4		0.844181		
FiPe5		0.816509		
FiPe6		0.807763		
FiPe7		0.824478		
FiPe8		0.803839		
FiPe9		0.985314		
FiPe10		0.838146		
FiPe1			0.763216	
FiPe2			0.804025	
FiPe3			0.814973	
FiPe4			0.846184	
FiPe5			0.815504	
FiPe6			0.803762	
OpIn1				0.666219
OpIn2				0.705025

Items	Business intelligence	Open innovation	Financial performance	Firm performance
Opln3				0.815978
Opln4				0.745181
Opln5				0.716509
Opln6				0.707763
Opln7				0.724476
Opln8				0.703838
Opln9				0.789314
Opln10				0.730148
Opln11				0.721924

#### 4.2. Convergent Validity

The degree to which the questions designed for each variable have the proper convergence for measuring the important variable and are capable of assessing that variable is known as convergent validity. The average extracted variance value (AVE) is examined in the partial least squares (PLS) approach. The value of AVE must be more than 0.5 in order to meet the standard for satisfactory convergent validity. The convergent validity of the questionnaire questions to measure each variable is appropriate, as shown in Table (3) below, where all the estimated AVE values are greater than 0.5. Average Variance Extracted (AVE) is a metric for comparing the variation collected by a construct to the variance resulting from measurement error.

**Table 3: AVE Mounts**

Variables	Average Variance Extracted (AVE)
Business intelligence	0.87
Open innova	0.84
Financial performance	0.81
Firm performance	0.79

#### 4.3. Divergent Validity

The meaning of divergent validity is that the questions related to the measurement of each variable do not overlap with other research variables. As can be seen, the values of the average root of the extracted variance (Table 4), which are placed in the matrix of the table, are larger than all the correlation values calculated in the same column.

**Table 4: Divergent validity**

Variables	Business intelligence	Open innovation	Financial performance	Firm performance
Business intelligence	0.85			
Open innovation	0.89	0.88		
Financial performance	0.86	0.79	0.73	
Firm performance	0.68	0.82	0.84	0.90

This leads to the conclusion that the research tool has an appropriate divergent validity, which means that the questions of each structure have a higher association with the linked structure than other structures.

#### 4.4. Descriptive Statistics

Table (5) shows the statistical description of the data in this research. The business intelligence variable among the samples of this research was equal to 2.84 with a standard deviation of 1.07, and the minimum score for this variable was 1, and the maximum score was 4.35. The open innovation variable's average across the samples in this study is 2.67, with a standard deviation of 0.96. The minimum score for this variable is 1.03, and the maximum score is 4.46. The financial performance variable among the samples of this research was equal to 2.19 with a standard deviation of 0.98, and the minimum score for this variable was 1.10, and the maximum score was 5. The average of the firm performance variable among the samples of this research was 2.20 with a standard deviation of 0.93, and the minimum score for this variable was 1.07 and the maximum score was 4.85.

**Table 5: Descriptive Statistics**

Variables	Minimum	Maximum	Average	Standard Deviation
Business intelligence	1	4.35	2.84	1.07



Open innovation	1.03	4.46	2.67	0.96
Financial performance	1.10	5	2.19	0.98
Firm performance	1.07	4.85	2.20	0.93

The following information outline the confirmation or denial of the current research's hypothesis based on the model evaluated in the Smart-PLS software and the model test results.

**4.5. Hypothesis Testing**

Table (6) shows the model tested in the Smart-PLS software and the model test results. The result of hypothesis 1 shows the value of the obtained t statistic is equal to 9.107, which is greater than 1.96, so it can be concluded that the above-mentioned hypothesis is confirmed at the confidence level of 95%. It shows that business intelligence has a significant effect on open innovation, and the value of this effect is equal to  $\beta=0.722$ . The result of hypothesis 2 shows the value of the t statistic obtained from the test is almost equal to 2.095, which is greater than 1.96, so it can be concluded that the above hypothesis is confirmed at a confidence level of 95%. Therefore, business intelligence has a significant impact on financial performance, and the value of this effect is equal to  $\beta=0.305$ . The result of hypothesis 3 shows the value of the t statistic obtained is equal to 3.154, which is greater than 1.96, so it can be concluded that the hypothesis is accepted at the confidence level of 95%. Therefore, business intelligence has a significant effect on the firm's performance. The result of the hypothesis shows the value of the standard path coefficient for the influence of business intelligence on a firm's performance is equal to  $\beta=0.415$ . The result of hypothesis 4 shows the value of the t statistic obtained is equal to 3.154, which is greater than 1.96, so it can be concluded that the hypothesis is accepted at the confidence level of 95%. Therefore, financial performance has a significant effect on the firm's performance. The result of the hypothesis shows the value of the standard path coefficient for the influence of business intelligence on a firm's performance is equal to  $\beta=0.443$ . Based on these findings in hypothesis 5, it is possible to conclude that the financial performance variable serves as a partial mediator in the impact of the business intelligence on the firm's performance. The total path coefficient of the mediating variable equals 0.35 and 0.39, showing that for one unit of change in the firm's financial performance, the firm's performance variable has a change of 35%, and 39% of these changes are due to changes in business intelligence. In the results of hypothesis 6, it is possible to conclude that the financial performance variable serves as a partial mediator in the impact of open innovation on the firm's performance. The total path coefficient of the mediating variable equals 0.37 and 0.41, showing that for one unit of change in the firm's financial performance, the firm's performance variable has a change of 37%, and 41% of these changes are due to changes in open innovation. The result of hypothesis 7 shows the value of the t statistic obtained is equal to 2.188, which is greater than 1.96, so it can be concluded that the hypothesis is accepted at the confidence level of 95%. Therefore, open innovation has a significant effect on financial performance. The result of the hypothesis shows the value of the standard path coefficient for the influence of open innovation on financial performance is equal to  $\beta=0.349$ . The result of hypothesis 8 shows the value of the t statistic obtained is equal to 3.154, which is greater than 1.96, so it can be concluded that the hypothesis is accepted at the confidence level of 95%. Therefore, open innovation has a significant effect on the firm's performance. The result of the hypothesis shows the value of the standard path coefficient for the influence of open innovation on a firm's performance is equal to  $\beta=0.413$ . Based on these findings in hypothesis 5, it is possible to conclude that the open innovation variable serves as a partial mediator in the impact of business intelligence on financial performance. The total path coefficients of the mediating variable equal to 0.38 and 0.36 show that for one unit of change in the financial performance, the business intelligence variable has a change of 38%, and 36% of these changes are due to changes in open innovation.

**Table 6: Test of Research Hypotheses**

Hypotheses	Standard path coefficient	t statistic	Result
H <sub>1</sub> : A higher level of business intelligence positively influences the development of open innovation.	0.722	9.107	Accepted
H <sub>2</sub> : A higher level of business intelligence positively influences the development of financial performance.	0.305	2.095	Accepted
H <sub>3</sub> : A higher level of business intelligence positively influences the development of a firm's performance.	0.415	3.154	Accepted
H <sub>4</sub> : A higher level of financial performance positively influences the development of a firm's performance.	0.443	3.154	Accepted
H <sub>5</sub> : Financial performance mediates the effect between business intelligence and a firm's performance.	Direct 0.35	Direct 3.05	Accepted
	Indirect 0.39	Indirect 2.88	
H <sub>6</sub> : Financial performance mediates the effects between open innovation and a firm's performance.	Direct 0.37	Direct 2.10	Accepted
	Indirect 0.41	Indirect 2.67	

Hypotheses	Standard path coefficient	t statistic	Result
H <sub>7</sub> : A higher level of open innovation positively influences the development of financial performance.	0.349	2.188	Accepted
H <sub>8</sub> : A higher level of open innovation positively influences the development of a firm's performance.	0.413	3.154	Accepted
H <sub>9</sub> : Open innovation mediates the effects of business intelligence on financial performance.	Direct 0.38	Direct 2.04	Accepted
	Indirect 0.36	Indirect 2.33	

## 5. CONCLUSION AND IMPLICATIONS

Businesses typically study and build business intelligence as a competence that can affect the information that is available. It is a potential internal organizational variable that could affect output (Caseiro and Coelho, 2019). Understanding business intelligence capabilities and how they work can help companies better integrate business intelligence into strategic management to boost company success (Chen and Lin, 2021). In order to successfully transfer the firm's usage of business intelligence and analytics into enhanced firm performance, practitioners must focus on increasing the firm's business intelligence and analytic-supported innovation capabilities (Božič and Dimovski, 2019). Financial effectiveness is positively and crucially impacted by business intelligence. Business intelligence, in particular, can enhance financial performance (Yang et al., 2022).

Managing and optimizing business performance is crucial for maintaining viability and achieving firm profitability in today's fast-paced and competitive business environment. Effective company performance management will integrate business analytics with open innovation to access performance. Hence, business intelligence can provide a framework for understanding which data is relevant for open innovation and business improvement within an organization.

## REFERENCES

- Abhari, K., & McGuckin, S. (2023). Limiting factors of open innovation organizations: A case of social product development and research agenda. *Technovation*, 119, 102526. <https://doi.org/10.1016/j.technovation.2022.102526>
- Ali, F. H., Ali, M., Malik, S. Z., Hamza, M. A., & Ali, H. F. (2020). Managers' open innovation and business performance in SMEs: a moderated mediation model of job crafting and gender. *Journal of Open Innovation: Technology, Market, and Complexity*, 6(3), 89. <https://doi.org/10.3390/joitmc6030089>
- Bahemia, H., & Roehrich, J. K. (2023). Governing open innovation projects: The relationship between the use of trust and legal bonds. *Industrial Marketing Management*, 110, 17-30. <https://doi.org/10.1016/j.indmarman.2023.02.008>
- Bashir, M., Alfalih, A., & Pradhan, S. (2023). Managerial ties, business model innovation & SME performance: Moderating role of environmental turbulence. *Journal of Innovation & Knowledge*, 8(1), 100329. <https://doi.org/10.1016/j.iik.2023.100329>
- Battisti, E., Alfiero, S., Quaglia, R., & Yahiaoui, D. (2022). Financial performance and global start-ups: the impact of knowledge management practices. *Journal of International Management*, 28(4), 100938. <https://doi.org/10.1016/j.intman.2022.100938>
- Bany Mohammad, A., Al-Okaily, M., Al-Majali, M., & Masa'deh, R. E. (2022). Business intelligence and analytics (BIA) usage in the banking industry sector: An application of the TOE framework. *Journal of Open Innovation: Technology, Market, and Complexity*, 8(4), 189. <https://doi.org/10.3390/joitmc8040189>
- Bigliardi, B., Dolci, V., Filippelli, S., Petroni, A., Pini, B., & Tagliente, L. (2023). The adoption of open innovation in manufacturing: a review. *Procedia Computer Science*, 217, 1765-1774. <https://doi.org/10.1016/j.procs.2022.12.376>
- Binzafrah, F., & Taleedi, F. (2022). The effect of business intelligence practices on job satisfaction in the Saudi Electricity Company in the Asir Region. *Journal of Money and Business*, (ahead-of-print). <https://doi.org/10.1108/JMB-03-2022-0011>
- Božič, K., & Dimovski, V. (2019). Business intelligence and analytics for value creation: The role of absorptive capacity. *International journal of information management*, 46, 93-103. <https://doi.org/10.1016/j.ijinfomgt.2018.11.020>
- Caseiro, N., & Coelho, A. (2019). The influence of Business Intelligence capacity, network learning and innovativeness on startups performance. *Journal of Innovation & Knowledge*, 4(3), 139-145. <https://doi.org/10.1016/j.iik.2018.03.009>
- Chang, X., & Li, J. (2019). Business performance prediction in location-based social commerce. *Expert Systems with Applications*, 126, 112-123. <https://doi.org/10.1016/j.eswa.2019.01.086>
- Cheah, S. L. Y., Ho, Y. P., & Li, S. (2021). Search strategy, innovation and financial performance of firms in process industries. *Technovation*, 105, 102257. <https://doi.org/10.1016/j.technovation.2021.102257>
- Chen, Y., & Lin, Z. (2021). Business intelligence capabilities and firm performance: A study in China. *International Journal of Information Management*, 57, 102232. <https://doi.org/10.1016/j.ijinfomgt.2020.102232>

- Chen, Y., & Lin, ZH. (2019). Business Intelligence Capabilities and Firm Performance: A Study in China. *International Journal of Information Management* volume 57 on page 102232. <https://doi.org/10.1016/j.ijinfomgt.2020.102232>
- Choi, J., Yoon, J., Chung, J., Coh, B. Y., & Lee, J. M. (2020). Social media analytics and business intelligence research: A systematic review. *Information Processing & Management*, 57(6), Article 102279. <https://doi.org/10.1016/j.ipm.2020.102279>
- Da Silva Meireles, F. R., Azevedo, A. C., & Boaventura, J. M. G. (2022). Open innovation and collaboration: A systematic literature review. *Journal of Engineering and Technology Management*, 65, 101702. <https://doi.org/10.1016/j.jengtecman.2022.101702>
- Drucker, P. F. (2002). The discipline of innovation. *Harvard business review*, 80(8), 95-102. <https://hbr.org/2002/08/the-discipline-of-innovation>
- Duque, J., Godinho, A., & Vasconcelos, J. (2022). Knowledge data extraction for business intelligence: A design science research approach. *Procedia Computer Science*, 204, 131-139. <https://doi.org/10.1016/j.procs.2022.08.016>
- Eidizadeh, R., Salehzadeh, R., & Chitsaz Esfahani, A. (2017). Analysing the role of business intelligence, knowledge sharing and organizational innovation on gaining competitive advantage. *Journal of Workplace Learning*, 29(4), 250-267. <https://doi.org/10.1108/JWL-07-2016-0070>
- Gaardboe, R., Nyvang, T., & Sandalgaard, N. (2017). Business Intelligence Success applied to Healthcare Information Systems. *Procedia Computer Science*, 121, 483-490. <https://doi.org/10.1016/j.procs.2017.11.065>
- Gassmann, O., Enkel, E., & Chesbrough, H. (2010). The future of open innovation. *R&D Management*, 40(3), 213-221. <https://doi.org/10.1111/j.1467-9310.2010.00605.x>
- Gök, O., & Peker, S. (2017). Understanding the links among innovation performance, market performance and financial performance. *Review of managerial science*, 11, 605-631. <https://doi.org/10.1007/s11846-016-0198-8>
- Harahap, I., Septiani, I., & Endri, E. (2020). Effect of financial performance on firms' value of cable companies in Indonesia. *Accounting*, 6(6), 1103-1110. <https://doi.org/10.5267/j.ac.2020.7.008>
- Huang, Z. X., Savita, K. S., Dan-yi, L., & Omar, A. H. (2022). The impact of business intelligence on the marketing with emphasis on cooperative learning: Case-study on the insurance companies. *Information Processing & Management*, 59(2), 102824. <https://doi.org/10.1016/j.ipm.2021.102824>
- Huang, Z. X., Savita, K. S., & Zhong-jie, J. (2022). The Business Intelligence impact on the financial performance of start-ups. *Information Processing & Management*, 59(1), 102761. <https://doi.org/10.1016/j.ipm.2021.102761>
- Huizingh, E. K. (2011). Open innovation: State of the art and future perspectives. *Technovation*, 31(1), 2-9. <https://doi.org/10.1016/j.technovation.2010.10.002>
- Kanzari, A., Rasmussen, J., Nehler, H., & Ingelsson, F. (2022). How financial performance is addressed in light of the transition to circular business models - A systematic literature review. *Journal of Cleaner Production*, 376, 134134. <https://doi.org/10.1016/j.jclepro.2022.134134>
- Lazzarotti, V., Manzini, R., & Pellegrini, L. (2010). Open innovation models adopted in practice: an extensive study in Italy. *Measuring business excellence*. <https://doi.org/10.1108/13683041011093721>
- Liu, H., Zhang, R., Zhou, L., & Li, A. (2023). Evaluating the financial performance of companies from the perspective of fund procurement and application: New strategy cross efficiency network data envelopment analysis models. *Energy*, 269, 126739. <https://doi.org/10.1016/j.energy.2023.126739>
- Liu, Z., Shi, Y., & Yang, B. (2022). Open innovation in times of crisis: An overview of the healthcare sector in response to the COVID-19 Pandemic. *Journal of Open Innovation: Technology, Market, and Complexity*, 8(1), 21. <https://doi.org/10.3390/joitmc8010021>
- Lu, Q., & Chesbrough, H. (2022). Measuring open innovation practices through topic modelling: Revisiting their impact on firm financial performance. *Technovation*, 114, 102434. <https://doi.org/10.1016/j.technovation.2021.102434>
- Manurung, E., Effrida, E., & Gondowonto, A. J. (2019). Effect of financial performance, good corporate governance and corporate size on corporate value in food and beverages. *International Journal of Economics and Financial Issues*, 9(6), 100. <https://doi.org/10.32479/ijefi.8828>
- Mariani, M., Baggio, R., Fuchs, M., & Höepken, W. (2018). Business intelligence and big data in hospitality and tourism: a systematic literature review. *International Journal of Contemporary Hospitality Management*. <https://doi.org/10.1108/ijchm-07-2017-0461>
- Menne, F., Surya, B., Yusuf, M., Suriani, S., Ruslan, M., & Iskandar, I. (2022). Optimizing the Financial Performance of SMEs Based on Sharia Economy: Perspective of Economic Business Sustainability and Open Innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 8(1), 18. <https://doi.org/10.3390/joitmc8010018>
- Moradi, E., Jafari, S. M., Doorbash, Z. M., & Mirzaei, A. (2021). Impact of organizational inertia on business model innovation, open innovation and corporate performance. *Asia Pacific Management Review*, 26(4), 171-179. <https://doi.org/10.1016/j.apmr.2021.01.003>
- Moro, S., Cortez, P., & Rita, P. (2015). Business intelligence in banking: A literature analysis from 2002 to 2013 using text mining and latent Dirichlet allocation. *Expert Systems with Applications*, 42(3), 1314-1324. <https://doi.org/10.1016/j.eswa.2014.09.024>
- Mouzas, S., & Bauer, F. (2022). Rethinking business performance in global value chains. *Journal of Business Research*, 144, 679-689. <https://doi.org/10.1016/j.ibusres.2022.02.012>

- Mushtaq, R., Gull, A. A., Shahab, Y., & Derouiche, I. (2022). Do financial performance indicators predict 10-K text sentiments? An application of artificial intelligence. *Research in International Business and Finance*, 101679. <https://doi.org/10.1016/j.ribaf.2022.101679>
- Nafasati, F., & Hilal, M. (2021). The effect of financial performance on firm value with corporate social responsibility as moderated variables. *Economics and Business Solutions Journal*, 5(1), 1-12. <http://dx.doi.org/10.26623/ebsj.v5i1.3327>
- Narteh, B. (2018). Brand equity and financial performance: The moderating role of brand likeability. *Marketing Intelligence & Planning*, 36(3), 381-395. <https://doi.org/10.1108/MIP-05-2017-0098>
- Nurdin, A. A., Salmi, G. N., Sentosa, K., Wijayanti, A. R., & Prasetya, A. (2023). Utilization of Business Intelligence in Sales Information Systems. *Journal of Information System Exploration and Research*, 1(1), 39-48. <https://doi.org/10.52465/joiser.v1i1.101>
- Ogink, R. H., Goossen, M. C., Romme, A. G. L., & Akkermans, H. (2022). Mechanisms in open innovation: A review and synthesis of the literature. *Technovation*, 102621. <https://doi.org/10.1016/j.technovation.2022.102621>
- Olszak, C. M. (2022). Business intelligence systems for innovative development of organizations. *Procedia Computer Science*, 207, 1754-1762. <https://doi.org/10.1016/j.procs.2022.09.233>
- Orzan, M. C., Burlacu, S., Florescu, M. S., Orzan, O. A., & Macovei, O. I. (2020). The effects of online marketing on financial performance in the textile industry. *Industria Textila*, 71(3), 288-293. <https://doi.org/10.35530/IT.071.03.1826>
- Park, G., & Song, M. (2020). Predicting performances in business processes using deep neural networks. *Decision Support Systems*, 129, 113191. <https://doi.org/10.1016/j.dss.2019.113191>
- Peters, M. D., Wieder, B., Sutton, S. G., & Wakefield, J. (2016). Business intelligence systems use in performance measurement capabilities: Implications for enhanced competitive advantage. *International Journal of Accounting Information Systems*, 21, 1-17. <https://doi.org/10.1016/j.accinf.2016.03.001>
- Ram, J., Zhang, C., & Koronios, A. (2016). The implications of big data analytics on business intelligence: A qualitative study in China. *Procedia Computer Science*, 87, 221-226. <https://doi.org/10.1016/j.procs.2016.05.152>
- Rao, P. M., & Vinod, H. D. (2023). Economic and financial performance of Indian IT services export firms. *Telecommunications Policy*, 102507. <https://doi.org/10.1016/j.telpol.2023.102507>
- Richards, G., Yeoh, W., Chong, A. Y. L., & Popovič, A. (2019). Business intelligence effectiveness and corporate performance management: an empirical analysis. *Journal of Computer Information Systems*, 59(2), 188-196. <https://doi.org/10.1080/08874417.2017.1334244>
- Salehi, N. (2022). How to properly apply new external knowledge: the waterfall model of absorptive capacity and innovation. *Journal on Innovation and Sustainability RISUS*, 13(2), 73-83. <https://doi.org/10.23925/2179-3565.2022v13i2p73-83>
- Salehi, N., & Asrar, M. M. The effect of open innovation mindset on absorptive capacity: The mediation role of entrepreneurial alertness. *Journal of Management Marketing and Logistics*, 9(4), 147-155. <https://dergipark.org.tr/en/pub/jimml/issue/75138/1232281>
- Seiler, A., Papanagnou, C., & Scarf, P. (2020). On the relationship between financial performance and position of businesses in supply chain networks. *International Journal of Production Economics*, 227, 107690. <https://doi.org/10.1016/j.ijpe.2020.107690>
- Shanak, H. S. H., & Abu-Alhaja, A. S. (2022). Does market performance mediates the nexus between production performance and financial performance in manufacturing companies?. *Journal of Islamic Marketing*, (ahead-of-print). <https://doi.org/10.1108/jima-11-2021-0370>
- Suša Vugec, D., Bosilj Vukšić, V., Pejić Bach, M., Jaklič, J., & Indihar Štemberger, M. (2020). Business intelligence and organizational performance: The role of alignment with business process management. *Business process management journal*, 26(6), 1709-1730. <https://doi.org/10.1108/BPMJ-08-2019-0342>
- Szromek, A. R., Kruczek, Z., Walas, B., & Polok, G. (2023). The method and scope of open innovation exchange in tourist destinations—Analysis of the opinions of tourism experts from Prague and Cracow. *Journal of Open Innovation: Technology, Market, and Complexity*, 9(1), 100005. <https://doi.org/10.1016/j.joitmc.2023.02.002>
- Thoumrungroje, A., & Racela, O. C. (2022). Innovation and Performance Implications of Customer–Orientation across Different Business Strategy Types. *Journal of Open Innovation: Technology, Market, and Complexity*, 8(4), 178. <https://doi.org/10.3390/joitmc8040178>
- Toroslu, A., Herrmann, A. M., Chappin, M. M., Schemmann, B., & Castaldi, C. (2023). Open innovation in nascent ventures: Does openness influence the speed of reaching critical milestones?. *Technovation*, 124, 102732. <https://doi.org/10.1016/j.technovation.2023.102732>
- Trzeciak, M., Sienkiewicz, Ł. D., & Bukłaha, E. (2022). Enablers of Open Innovation in Software Development Micro-Organization. *Journal of Open Innovation: Technology, Market, and Complexity*, 8(4), 174. <https://doi.org/10.3390/joitmc8040174>
- Tseng, F. M., Liang, C. W., & Nguyen, N. B. (2023). Blockchain technology adoption and business performance in large enterprises: A comparison of the United States and China. *Technology in Society*, 102230. <https://doi.org/10.1016/j.techsoc.2023.102230>
- Türegün, N. (2022). Financial performance evaluation by multi-criteria decision-making techniques. *Heliyon*, 8(5), e09361. <https://doi.org/10.1016/j.heliyon.2022.e09361>

Wang, J., Omar, A. H., Alotaibi, F. M., Daradkeh, Y. I., & Althubiti, S. A. (2022). Business intelligence ability to enhance organizational performance and performance evaluation capabilities by improving data mining systems for competitive advantage. *Information Processing & Management*, 59(6), 103075. <https://doi.org/10.1016/j.ipm.2022.103075>

Wu, Y., & Huang, S. (2022). The effects of digital finance and financial constraint on financial performance: Firm-level evidence from China's new energy enterprises. *Energy Economics*, 112, 106158. <https://doi.org/10.1016/j.eneco.2022.106158>

Xu, Y., Li, X., bin Mustakim, F., Alotaibi, F. M., & Abdullah, N. N. (2022). Investigating the business intelligence capabilities' and network learning effect on the data mining for start-up's function. *Information Processing & Management*, 59(5), 103055. <https://doi.org/10.1016/j.ipm.2022.103055>

Yang, M., Sulaiman, R., Yin, Y., Mallamaci, V., & Alrabaiah, H. (2022). The effect of business intelligence, organizational learning and innovation on the financial performance of innovative companies located in Science Park. *Information Processing & Management*, 59(2), 102852. <https://doi.org/10.1016/j.ipm.2021.102852>

Zamecnik, R., & Rajnoha, R. (2015). Strategic business performance management on the base of controlling and managerial information support. *Procedia Economics and Finance*, 26, 769-776. [https://doi.org/10.1016/s2212-5671\(15\)00843-6](https://doi.org/10.1016/s2212-5671(15)00843-6)

Zhang, L., Qi, Z., & Meng, F. (2022). A review on the construction of business intelligence system based on unstructured image data. *Procedia Computer Science*, 199, 392-398. <https://doi.org/10.1016/j.procs.2022.01.048>