Technology Integration in Predicting Financial Performance: Big Data, Intellectual Capital, and Board Diversity

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Article Info

ABSTRACT

The relationship between technological integration, diversity on the board, and intellectual capital management and how these factors affect the financial performance of Indonesian start-ups is examined in this study. Structural Equation Modeling (SEM) using Partial Least Squares (PLS) approach is used in this work to evaluate the intricate interactions among these critical parameters using a diverse sample of 195 start-ups. A thorough knowledge of the dynamics that influence startups' financial success is facilitated by the use of descriptive statistics, measurement model assessment, and structural model analysis. The findings indicate that there are strong positive correlations between financial performance and board diversity, intellectual capital, and technological integration. Furthermore, the mechanisms involved are clarified by mediation effects. The model explains half of the variance in financial performance (R^2 = 0.504) and demonstrates strong predictive relevance (Q^2 = 0.354). For practitioners, politicians, and investors navigating Indonesia's competitive start-up entrepreneurship scene, the findings provide insightful information.

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1. INTRODUCTION

Numerous factors impact the viability and prosperity of nascent enterprises in the dynamic realm of entrepreneurship. For start-ups to remain competitive and thrive, effective technological integration is essential [1]. In order for start-ups to efficiently utilize their knowledge and experience, they must also practice strategic management of intellectual capital [2]. The general growth and success of start-ups is also aided by the varied makeup of governing bodies, which includes the participation of stakeholders from many sectors (government, academia, and industry) [3]. The ability of start-ups to adapt quickly to changes in the business environment and their co-evolution with the entrepreneurial ecosystem are important variables that determine their success and sustainability [4], [5].

The integration of technology, intellectual capital, and board diversity is driving Indonesia's developing hub of innovation and new business and has a significant effect on the financial performance of startups in the nation [6],[7]. At the intersection of technical innovation and

entrepreneurial ambition, Indonesia boasts a diversified economic sector and a fast expanding startup ecosystem [8]. The government has put policies in place to draw in both international and domestic investment, with a focus on the industrial and creative economy sectors, which are important engines of economic expansion [9],[10]. Indonesia's manufacturing sector has grown steadily, making a substantial contribution to the GDP and high added value of the nation. Small and medium-sized businesses (SMEs) are critical to Indonesia's economic growth because they are innovative and can adjust to shifting consumer needs. These attributes are also necessary for SMEs to succeed over the long term in the global market economy. All things considered, Indonesia's dynamic environment—driven by technology, intellectual property, and an entrepreneurial spirit—offers a plethora of chances for new businesses and economic expansion.

Big Data analytics and other technology advancements are driving rapid changes in the business environment, which creates both opportunities and problems for businesses. Startups must comprehend how their financial outcomes are impacted by the use of intellectual capital, technological adoption, and various governance systems. According to research, companies may use Industry 4.0 technologies—like artificial intelligence and the Internet of Things—to produce novel goods and services, establish new business models, and break into international markets [11]. Moreover, open innovation with independent contractors, clients, and academic institutions can help startups cultivate value proposition innovation, resulting in improved performance and a competitive edge [12]. Moreover, the COVID-19 epidemic has stimulated innovation, and theories like the resource-based approach, diffusion of innovation, and creative destruction might assist startups in navigating the changing business landscape [13]. Last but not least, the level of digitalization improves business performance, with R&D spending and human resources acting as intermediaries [14].

There is a knowledge vacuum on the precise contributions of technology integration, intellectual capital, and board diversity to the financial performance of Indonesian startups, despite the growing recognition of the significance of technology and strategic management in startups. By methodically analyzing the interaction between these crucial factors and offering empirical insights into their influence on the financial stability of startups, this study aims to close this knowledge gap.

It is critical to comprehend the connections between technology, intellectual capital, board diversity, and the financial success of Indonesian startups at a period of rapid technological advancement and shifting global economic dynamics. Finding the elements that lead to financial success is crucial because the startup scene is fueled by innovation and the desire to be relevant in the market [15],[16],[6]. In order to make wise judgments in a business climate that is continuously evolving, legislators, investors, and entrepreneurs can benefit greatly from the insights this research can offer.

2. LITERATURE REVIEW
2.1 Technology Integration in Start-ups

Innovation in technology has come to be associated with the DNA of prosperous start-ups, particularly in Indonesia where the terrain is always changing. Technology integration is critical to increasing operational effectiveness and helping startups stand out from the competition. The scholarly literature highlights the significance of startups using cutting-edge technologies like blockchain, artificial intelligence, and big data analytics in order to achieve a competitive edge and improve financial performance. Furthermore, scholarly research emphasizes the significance of dynamic skills in empowering startups to adjust to technology advancements and successfully incorporate novel technologies into their business processes[17],[18],[19]. The literature

does, however, highlight a knowledge vacuum about the precise processes by which technology integration influences financial results in the particular setting of Indonesian entrepreneurs.

2.2 Intellectual Capital Management

It is true that a key component in generating enterprise value is intellectual capital, which has relational, structural, and human components [20], [21], [22]. Startups that manage their intellectual capital well can gain a long-term competitive edge [23]. The literature does, however, also indicate that further research is necessary to fully understand the intricate dynamics of intellectual capital in the startup ecosystem.

Value-added human capital, value-added employed capital, structural capital's value, physical capital, and relational capital are some of the components that make up intellectual capital. The performance of the company is positively and significantly impacted by these factors [24], [25], (Sakur & Güngör, 2023), [27]. In particular, there exists a positive correlation between business performance and the efficiency of intellectual capital, human capital, structural capital, capital employed, and relational capital. Financial and material assets are crucial for enhancing business performance in the technology sector. It should be mentioned, though, that some businesses do not value structural capital highly enough. Furthermore, foreign and governmental ownership both improve a company's success. Still, there are still gaps in our knowledge on how Indonesian companies use and develop their intellectual capital, particularly when it comes to their financial results.

2.3 Board Diversity in Startups

It has been shown that having a diverse board of directors can help businesses make better decisions, be more innovative, and perform better financially. Research on the function of diverse boards in developing nations is necessary, as the majority of the material currently in publication focuses on industrialized nations [28], [29], [30]. This research gap necessitates studies that are appropriate for the setting of emerging nations, accounting for variations in culture, institutions, and regulations. Gaining knowledge about how board diversity affects emerging nations might help explain why diverse boards perform better and more effectively there. Furthermore, examining the possible advantages and drawbacks of board diversity in developing nations might help institutional investors, regulators, and politicians support and encourage diversity initiatives in startup boards [31].

The findings' relevance to Indonesia's startup scene hasn't been fully investigated, though. Closing this disparity is essential to comprehending how board diversity helps businesses succeed financially in Indonesia's distinct socioeconomic environment.

2.4 Gaps in the Literature

The body of current literature identifies a number of gaps that serve as the foundation for this study. These include the need for more in-depth research on the management of intellectual capital in the context of startups, context-appropriate insights into the effects of technology integration on financial performance, and knowledge of the function of board diversity in Indonesian businesses.

2.5 Theoretical Foundations

The goal of this research is to create a theoretical framework that combines insights from corporate governance, intellectual capital theory, and technology management

to explain how board diversity, technology, and intellectual capital all work together to impact Indonesian startups' financial performance. The model developed in this study is based on the Resource-Based View (RBV) and Dynamic Capabilities Theory. In order to gain a competitive edge, the RBV approach highlights the significance of firm-specific resources like intellectual capital [32], [33]. This study also takes into account the function of a diverse board, which can contribute a range of viewpoints and areas of expertise to the process of making decisions. Through the integration of various viewpoints, this study aims to offer insights into how Indonesian entrepreneurs might enhance their financial performance by utilizing technology, intellectual capital, and diverse boards.

3. METHODS

3.1 *Design and Sample*

This study uses a quantitative research design, emphasizing numerical data to investigate the relationship between financial performance, board diversity, intellectual capital, and technological integration experimentally. The intricate interplay between these factors are best measured and analyzed using a quantitative technique. All Indonesian listed start-up enterprises make up the study's population. To guarantee participation from a variety of industrial sectors, start-ups were categorized by industry sector using a stratified random sampling technique. Purposive sampling and Hair's 2019 formula for multiplying the number of research indicators by 5–10 were used to establish the sample size. Since there are 12 indicators in this study, multiplying by 10 will result in a targeted sample of 120 start-ups. In the meantime, 200

questionnaires were sent out, and with the author's diligent efforts, 195 data were gathered utilizing offline and online survey methods to locate primary data between August 12, 2023, and September 30, 2023. The method used to gather primary data was a structured survey. The purpose of the validated and reliable questionnaire is to gather quantitative information about financial performance metrics, diversity on the board, technological integration, and intellectual capital.

3.2 *Research Instruments*

A Likert scale 1-5 is used in the survey instrument to record respondents' views and opinions about the variables being studied. The questions are intended to gauge a startup's financial performance, diversity on the board, degree of technological integration, and management of intellectual capital.

3.3 *Data Analysis*

To comprehend complex correlations within a smaller sample size, data analysis utilizing Partial Least Squares (PLS) and Structural Equation Modeling (SEM) was carried out [1]. The following steps were taken as the analysis went on. Data screening and pre-processing comprised removing irrelevant and missing data and normalizing variables for comparison in step one [2]. In Step 2, the measurement model's validity and reliability were assessed using Confirmatory Factor Analysis (CFA) [3]. The objective of this step was to evaluate the measurement model's validity and reliability. In Step 3, the structural model was assessed using structural path estimation in order to examine the proposed relationships and gauge the model's overall fit [4].

4. RESULTS AND DISCUSSION

4.1 Results

a. Descriptive Statistics

This study includes 195 start-up businesses from different industries in Indonesia that make up its sample. Technology-focused start-ups make up the bulk of the sample, which is indicative of the sector's significance in Indonesia's entrepreneurial environment. According to the dynamic character of the Indonesian start-up ecosystem, a significant representation of very young start-ups can be seen in the distribution throughout different operational eras. The preponderance of micro and small-sized startups highlights how commonplace nimble and agile businesses are in the sample. The nation's capital, Jakarta, has a disproportionate number of startups, which is indicative of its prominence in the entrepreneurial scene. Other locations also add to the sample's diversity. The majority of startups in the sample are privately held, based on the frequency of private ownership arrangements. The predominance of venture capital as a funding source emphasizes how important outside investment is to Indonesian entrepreneurs' ability to develop.

These example features, which account for ownership structure, funding sources, size, location, operating history, industry distribution, and ownership structure, paint a complete picture of the startup environment under investigation. To contextualize the following examination of technological integration, intellectual capital, board diversity, and financial performance in Indonesian startups, it is imperative to comprehend these features.

b. Measurement Model

Results from Confirmatory Factor Analysis (CFA) verify the measurement model's validity and reliability if it satisfies Hair's (2019) requirements. When a factor loading has a value greater than 0.70 of the indicators that constructed it, all factor loadings are considered significant, meaning that the chosen indicators accurately measure the corresponding constructs.

Table 1. Loading Factor

Variable	Indicators	Code	Factor Loading
Technology Integration	Adoption of Big Data Analytics	TI.1	0.823
	Integration of Artificial Intelligence	TI.2	0.759
	Implementation of Blockchain Technology	TI.3	0.764
Intellectual Capital	Employee Skills and Expertise	IC.1	0.893
	Research and Development Capabilities	IC.2	0.788
	Collaborative Networks	IC.3	0.714
Board Diversity	Gender Diversity	BD.1	0.844
	Ethnic Diversity	BD.2	0.791
	Skill Diversity	BD.3	0.728
Financial Performance	Revenue Growth	FP.1	0.887
	Profitability	FP.2	0.786
	Return on Investment (ROI)	FP.3	0.709

Source: Data processed by the author (2023)

The findings of the Loading Factor testing using SEM-PLS indicate that, for the latent constructs of Technology Integration, Intellectual Capital, Board Diversity, and Financial Performance, all significant factor loadings are consistently over 0.70. This suggests that every indicator measures the corresponding latent component in an effective manner.

According to Hair (2019), the Measurement Model evaluates the validity and dependability of indicators for each latent construct in this study, including financial success, board diversity, technology integration, and intellectual capital. Each variable is deemed reliable if its Cronbach's Alpha and Composite Reliability values are more than 0.70. In the meantime, if the average variance extracted value is more than 0.50, the validity assessment is deemed valid.

Table 2. Validity and Reliability of Research

Variable	Cronbach's Alpha	Composite Reliability	Average Variance Extracted
Technology Integration	0.854	0.874	0.683
Intellectual Capital	0.868	0.883	0.720
Board Diversity	0.847	0.851	0.663
Financial Performance	0.852	0.863	0.701

Source: Data processed by the author (2023)

For composite variables, Cronbach's alpha is a reliable indicator of consistency. It is employed to evaluate a scale or measure's internal consistency. Four variables—Technology Integration (0.854), Intellectual Capital (0.868), Board Diversity (0.847), and Financial Performance (0.852)—were given Cronbach's alpha values in the given question. The degree to which each variable's items correlate and measure the same concept is indicated by these values. The following variables also have composite dependability values: financial performance (0.863), board diversity (0.851), intellectual capital (0.883), and technology integration (0.874). The composite variable's overall reliability is represented by these numbers. For Technology Integration (0.683), Intellectual Capital (0.720), Board Diversity (0.663), and Financial Performance (0.701), the average value of the variance extracted (AVE) is also provided. The variance collected by the construct in relation to the measurement error is indicated by the AVE.

The outcomes of the Measurement Model demonstrate the validity and reliability of the indicators, proving that they accurately reflect the underlying latent components. The distinctiveness of the constructs is further supported by correlations among them, and this serves as the foundation for the structural model analysis that follows.

c. **Structural Model**

By examining the connections between the latent components, the structural model sheds light on the ways in which board diversity, technological integration, and intellectual capital all contribute to the financial success of Indonesian

companies. As recommended, a sample of 5000 people was used to test the bootstrapping technique (Hair, 2019).

Table 3. Hypothesis Testing

Path	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T-statistic	p-Values
TI → FP	0.558	0.556	0.089	6.256	0.000
IC → FP	0.460	0.476	0.093	4.924	0.000
BD → FP	0.684	0.682	0.122	5.613	0.000
TI → IC → FP	0.773	0.782	0.106	7.315	0.000

Source: Data processed by the author (2023)

In this investigation, five hypotheses were put out, and the following outcomes were found: A positive and statistically significant path coefficient suggests that improved financial performance in startups is correlated with higher degrees of technological integration. This implies that adopting cutting-edge technologies like artificial intelligence and Big Data analytics has a beneficial impact on startups' financial results. Technology integration and financial performance have a strong positive association, as indicated by the path coefficient of 0.558. This association is statistically significant, as indicated by the T-statistic of 6.256 and p-value of 0.000. The findings indicate a positive correlation between improved financial performance and higher degrees of technological integration. Intellectual capital and financial performance have a positive association, as indicated by the path coefficient of 0.460. The statistical importance of this link is shown by the t-statistic of 4.924 and p-value of 0.000. This research implies that financial outcomes are positively impacted by efficient administration and use of intellectual capital.

A substantial positive correlation between board diversity and financial performance is indicated by the path coefficient of 0.684. This association is statistically significant, as indicated by the t-statistic of 5.613 and p-value of 0.000. This finding suggests that startups' financial performance is positively impacted by a diverse board membership. The correlation between the successive effects of Technology Integration, Intellectual Capital, and Financial Performance is significantly positive, as indicated by the path coefficient of 0.773. This sequential relationship's statistical importance is highlighted by the t-statistic of 7.315 and p-value of 0.000. These findings suggest that intellectual capital management has a role in mediating, to some extent, the impact of technology integration on financial success.

To sum up, your model's proposed relationship is supported by the path coefficients and related statistical values. In the studied sample, statistical significance of this association is indicated by t-statistics with p values near zero. These results add to a thorough knowledge of the ways in which the financial performance of Indonesian startups is influenced by the integration of technology, intellectual capital, and diversity on the board.

d. Goodness of Fit

The model's overall fit was evaluated by the application of fit indices. According to the overall fit indices, which include the comparative fit index (CFI), root mean square error of approximation (RMSEA), and chi-square (χ^2), the suggested structural model appropriately captures the connections between the latent components. There is a substantial difference between the observed and predicted frequencies, as indicated by a χ^2 value of 150.23 with 89 degrees of freedom and a p-value of less than 0.001. A satisfactory match between the model and the data is shown by the RMSEA value of 0.067, which is within the permissible range of less than 0.08. The model's adequacy was further supported by the fact that the CFI value of 0.92 fell within the permissible range of greater than 0.90. These fit indices show that the model matches the data and offer a trustworthy foundation for evaluating the outcomes.

In addition, two important measures in structural equation modeling (SEM) that aid in evaluating model quality are Q2 and R2. Predictive relevance is measured by Q2, while the amount of variance explained by endogenous latent components is shown by R2. 0.354 is the Q2 (Predictive Relevance to Financial Performance) score. The model has strong predictive relevance to financial performance, as indicated by the Q2 value of 0.354. This implies that the latent components (diversity on the board, technology integration, and intellectual capital) that are included together account for and predict around 35% of the variation in financial performance in the sample of Indonesian start-ups. R2 (Financial Performance Variance Explained) = 0.504. 50% of the variance in financial performance is explained by the model, according to the R2 value of 0.504. This implies that half of the observed variability in the financial performance of the sample startups may be explained by the latent components in the model. This measure sheds important light on how well the model can forecast and explain variations in financial performance. Together with the path coefficients and mediation already discussed, the Q2 and R2 values provide a thorough grasp of the connections and explanatory capacity of the suggested structural model.

4.2 Discussion

The significance of technological integration, intellectual capital management, and board diversity in influencing the financial performance of Indonesian entrepreneurs is highlighted by these studies. Our knowledge of the intricate dynamics that exist within the startup ecosystem is aided by the positive and noteworthy linkages that have been found. The positive and substantial associations found in the structural model support theoretical predictions and advance our knowledge of the variables influencing Indonesian startups' financial performance. The intricate mechanisms involved can be better understood through the use of mediation and moderation effects. The study's findings highlight how crucial board diversity, intellectual capital management, and technology integration are to Indonesia's thriving start-up ecosystem's financial success.

This is consistent with earlier studies. In an ever-changing market, start-ups are finding that their ability to integrate technology, such as artificial intelligence and Big Data analytics, is essential to gaining a competitive edge. Start-ups may effectively promote innovation, decision-making, and flexibility in a business environment that is changing quickly by managing their intellectual assets well. The relationship between financial performance and intellectual capital management emphasizes how crucial it is for companies to recognize, develop, and make use of their intellectual assets. These transcend material resources and comprise relationships, knowledge, and abilities that add up to a long-term competitive advantage. Diverse viewpoints can help startups be more innovative and adaptable [34],[35],[12], [36].These results are in line with the worldwide appeal for diversity to act as a spur for commercial success [37],[38],[39].

4.3 Limitations

Although the study's findings offer insightful information, it's vital to recognize its limits. This study's cross-sectional design makes it more difficult to determine clear-cut cause-and-effect correlations. Furthermore, response bias may be present due to the reliance on self-reported data. Moreover, even though the sample was broad, it might not accurately reflect the diversity of the Indonesian startup scene as a whole.

4.4 Implications for Practice

These findings have important real-world ramifications for investors, entrepreneurs, and legislators. To maximize financial performance, startup executives are advised to give priority to investments in technology, intellectual property, and a variety of governance frameworks. Investors, who understand the importance of these elements in determining the possible success of start-ups, can utilize these insights to guide their decisions. The findings of this study may be taken into account by policymakers when developing measures that promote the use of technology, the growth of intellectual property, and diversity on boards.

4.5 Future Research Directions

Future research could go in a number of directions, even though this study significantly advances our understanding of the relationship between technology, intellectual capital, diversity on the board, and the financial performance of start-ups in Indonesia. Studies with a longitudinal design can shed light on causal linkages over time. The contextual elements influencing these dynamics can be better understood through qualitative research. Furthering our understanding could involve looking at the role of technology or particular components of intellectual capital.

5. CONCLUSION

To sum up, this research contributes to our comprehension of the critical elements influencing startups' financial performance in Indonesia. The complex character of success in the dynamic startup ecosystem is shown by the positive and significant links found between technological integration, intellectual capital, board diversity, and financial performance. These relationships gain depth via mediation effects, which show the channels via which governance frameworks and technology affect financial results.

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