

Effect of Access to Capital, Entrepreneurship Education, and HR Competencies on Start-up Success in the Technology Sector

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Article Info

Article history:

Received August, 2024

Revised August, 2024

Accepted August, 2024

Keywords:

Start-up Success

Access to Capital

Entrepreneurship Education

Human Resource Competencies

Technology Sector

ABSTRACT

This study examines the impact of access to capital, entrepreneurship education, and human resource (HR) competencies on the success of start-ups in the technology sector. Utilizing a quantitative approach, data were collected from 150 start-up firms through structured questionnaires using a Likert scale ranging from 1 to 5. The data were analyzed using Structural Equation Modeling-Partial Least Squares (SEM-PLS 3). The results indicate that all three factors—access to capital, entrepreneurship education, and HR competencies—positively and significantly influence start-up success. Access to capital allows start-ups to invest in research and development, scale operations, and attract top talent, while entrepreneurship education equips entrepreneurs with essential skills for strategic decision-making. HR competencies, as the strongest predictor, underscore the critical role of a skilled workforce in driving innovation and sustaining growth in the technology sector. The findings provide valuable insights for entrepreneurs, educators, and policymakers seeking to support the development and success of technology start-ups.

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1. INTRODUCTION

The success of start-ups in the rapidly evolving technology sector is influenced by several critical factors, including access to capital, entrepreneurship education, and human resource (HR) competencies. These elements are essential for navigating the challenges of intense competition, technological disruptions, and the necessity for continuous innovation. Access to capital is a fundamental determinant of start-up success. It provides the necessary resources for research and development, marketing, and scaling operations. [1] highlights that

financial backing is crucial for start-ups to innovate and compete effectively in the technology sector, as it allows them to invest in cutting-edge technologies and talent acquisition. Similarly, [2] emphasizes the importance of venture capital and other funding sources in enabling start-ups to sustain their growth and adapt to market changes. Entrepreneurship education plays a pivotal role in equipping founders with the skills and knowledge needed to manage and grow their businesses. [3] underscores the significance of educational programs that focus on entrepreneurial skills, which

enhance the ability of start-ups to innovate and respond to market demands. This education fosters a mindset of continuous learning and adaptability, which is crucial in the fast-paced technology sector. HR competencies are also vital for start-up success. The ability to attract, develop, and retain skilled employees is a key factor in maintaining a competitive edge. [4] discuss how effective HR practices, such as talent management and organizational culture development, contribute to the overall performance and sustainability of start-ups. Additionally, Islam Ahmad Ibrahim Ahmad and colleagues highlight the role of leadership and team dynamics in fostering an innovative and productive work environment [2].

Access to capital is a critical determinant of success for start-ups in the technology sector, as it enables them to invest in essential areas such as research and development, talent acquisition, and marketing. The relationship between capital access and start-up success is multifaceted and has been explored in various studies. Research by [4] highlights that start-ups with sufficient funding can better navigate the competitive landscape by investing in innovative product development and scaling operations efficiently. This access to capital allows them to leverage technological advancements and maintain a competitive edge in the market. [5] further supports this by emphasizing that financial resources are crucial for start-ups to attract and retain top talent, which is essential for driving innovation and achieving long-term success. The ability to offer competitive salaries and benefits packages is often contingent on the availability of adequate funding. [6] adds another dimension by discussing how access to capital influences a start-up's ability to market its products effectively. With sufficient funding, start-ups can implement comprehensive marketing strategies that enhance brand visibility and customer acquisition, thereby increasing their market share and potential for success. However, [7] suggest that while access to capital is vital, it is not the sole determinant of success. Factors such as the entrepreneurial ecosystem,

regulatory environment, and the start-up's strategic vision also play significant roles. This indicates that while capital is necessary, it must be complemented by other supportive elements to maximize its impact. Finally, research by [8] highlights potential challenges, such as the risk of over-reliance on external funding, which can lead to unsustainable business practices if not managed properly. This underscores the importance of strategic financial management alongside capital acquisition.

Entrepreneurship education is widely recognized for its role in enhancing the capabilities of founders and their teams, particularly in the context of technology-based start-ups. This education typically covers essential areas such as business planning, financial management, marketing, and leadership, which are crucial for strategic decision-making and overall business success. Research indicates that entrepreneurship education significantly impacts start-up performance by equipping entrepreneurs with the skills necessary to navigate complex business environments. For instance, [9] highlight that entrepreneurship education fosters critical thinking and problem-solving skills, which are vital for the innovative processes required in technology-driven industries. Similarly, [10] emphasizes the importance of entrepreneurship education in developing a strategic mindset, which is crucial for technology start-ups that operate in rapidly changing markets. Moreover, [11] suggests that entrepreneurship education enhances the ability of start-up teams to effectively manage resources and adapt to market demands, thereby improving their chances of success. This adaptability is particularly important for technology-based start-ups, which often face unique challenges such as rapid technological advancements and intense competition. However, the extent to which entrepreneurship education contributes to the success of technology-based start-ups can vary. [12] point out that while entrepreneurship education provides a strong foundation, the dynamic nature of the technology sector requires continuous learning and adaptation beyond formal

education. This suggests that while entrepreneurship education is beneficial, it must be complemented by ongoing experiential learning and industry engagement. [13] further argues that the impact of entrepreneurship education on start-up success is contingent upon the alignment of educational content with industry needs and the practical application of learned skills.

The role of HR competencies in technology start-ups is crucial for fostering innovation and maintaining competitiveness, yet empirical validation in this specific context is limited. The available research highlights several key aspects of HR competencies that are particularly relevant to technology start-ups. Firstly, the ability to adapt to rapid technological changes is a critical competency. Start-ups in the technology sector operate in a dynamic environment where technological advancements occur swiftly. HR competencies that emphasize flexibility and continuous learning are essential for teams to keep pace with these changes and leverage new technologies effectively [14], [15]. Moreover, fostering a culture of innovation is another significant aspect. HR practices that encourage creativity and risk-taking can lead to a more innovative organizational culture. This is particularly important in start-ups, where the ability to innovate can determine success or failure. Effective HR strategies that promote open communication and collaboration can enhance the innovative capabilities of the workforce [16], [17]. Additionally, the alignment of HR competencies with the start-up's vision is vital. A motivated and skilled workforce can drive the execution of the start-up's strategic goals. This requires HR to not only focus on recruiting individuals with the right technical skills but also those who share the start-up's values and vision. This alignment ensures that the workforce is not only competent but also committed to the start-up's long-term objectives [15], [18]. However, the research also indicates some challenges. For instance, the fast-paced nature of technology start-ups can lead to high employee turnover, which

can disrupt the continuity of innovation efforts. Therefore, HR strategies must also focus on retention and employee engagement to sustain innovation over time [17]. This study aims to investigate the effects of access to capital, entrepreneurship education, and HR competencies on the success of start-ups in the technology sector.

2. LITERATURE REVIEW

2.1 Access to Capital and Start-up Success

Access to capital is a critical determinant of start-up success, particularly in the technology sector, where substantial financial resources are necessary for research and development, scaling operations, and bringing innovative products to market. The availability of capital not only provides the financial means to execute business plans but also serves as a signal of a start-up's viability and potential to external stakeholders, including investors, partners, and customers. This signaling effect can enhance a start-up's reputation and credibility, making it more attractive to potential collaborators and clients [4]. Research indicates that start-ups with greater access to capital are better positioned to attract top talent, invest in cutting-edge technology, and withstand early-stage financial pressures that often lead to business failure [19]. This is particularly important in the technology sector, where the costs associated with product development, patenting, and market entry are high. Access to capital allows start-ups to invest in necessary resources and infrastructure, which can be pivotal in achieving competitive advantage and long-term sustainability [5]. However, despite its importance, securing funding remains a significant challenge for tech start-ups, especially in the early stages. The high-risk nature of technology ventures and the uncertainty surrounding their long-term profitability often deter potential investors [8]. This creates a paradox where the need for capital is greatest when it is hardest to obtain. Understanding the specific impact of access to capital on start-up success is crucial for developing strategies to support

entrepreneurs in overcoming these financial barriers. Effective strategies might include fostering stronger networks between start-ups and investors, enhancing transparency in financial reporting, and providing targeted government support to mitigate risks for early-stage investors [7]. By addressing these challenges, stakeholders can better support the growth and success of technology start-ups, ultimately contributing to innovation and economic development.

2.2 Entrepreneurship Education and Start-up Success

Entrepreneurship education plays a crucial role in enhancing start-up success by equipping individuals with the necessary skills, knowledge, and mindset to navigate the complexities of launching and managing a business. Research indicates that formal entrepreneurial training significantly contributes to the viability and sustainability of new ventures. Firstly, entrepreneurship education fosters critical thinking and problem-solving skills, which are essential for identifying and exploiting business opportunities. According to [9], entrepreneurship education enhances students' ability to innovate and adapt to changing market conditions, thereby increasing their chances of success in the competitive business environment. This adaptability is crucial for start-ups, which often face unpredictable challenges. Moreover, [10] highlights that entrepreneurship education provides a structured framework for understanding business operations, financial management, and strategic planning. This comprehensive understanding enables aspiring entrepreneurs to make informed decisions, reducing the likelihood of failure due to poor management practices. The ability to develop a robust business plan and execute it effectively is a key outcome of such educational programs. [11] further emphasizes the importance of entrepreneurship education in building a supportive network of mentors and peers. These networks offer valuable resources, guidance, and support, which are instrumental in overcoming the initial hurdles

of starting a business. The collaborative environment fostered by entrepreneurship education encourages knowledge sharing and collective problem-solving, enhancing the overall success rate of start-ups. Additionally, [20] note that entrepreneurship education instills a growth mindset, encouraging resilience and perseverance among entrepreneurs. This mindset is vital for navigating the inevitable setbacks and failures encountered in the entrepreneurial journey. However, [13] points out that while entrepreneurship education is beneficial, it is not a panacea for all start-up challenges. The effectiveness of such education can vary based on the quality of the program, the commitment of the participants, and the external business environment.

2.3 Human Resource Competencies and Start-up Success

Human resource (HR) competencies are pivotal for start-ups in the technology sector, as they significantly influence the ability to innovate, adapt, and execute strategic visions. The literature underscores the importance of these competencies in several key areas. Firstly, HR competencies are crucial for fostering innovation within start-ups. According to [14], the development of a skilled workforce enhances a start-up's capacity to generate new ideas and implement innovative solutions, which is essential in the fast-paced technology sector. This is supported by [15], who highlight that a workforce equipped with the right skills and knowledge can effectively leverage technological advancements to create competitive advantages. Moreover, the ability to adapt to changing market conditions is another critical aspect where HR competencies play a vital role. [16] emphasize that start-ups with a workforce that possesses strong adaptive skills are better positioned to respond to market shifts and emerging trends, ensuring sustained growth and relevance. This adaptability is further reinforced by [18], who argue that HR competencies enable start-ups to pivot their strategies and operations in response to external pressures, thereby maintaining their market position. Finally,

executing a strategic vision requires a workforce that not only understands the start-up's goals but also possesses the necessary skills to achieve them. [21] discuss how HR competencies, such as strategic thinking and leadership, are integral to aligning the workforce with the start-up's objectives, facilitating effective implementation of strategic plans.

2.4 Theoretical Framework

This study is grounded in the Resource-Based View (RBV) of the firm, which posits that a firm's resources and capabilities are central to its competitive advantage and long-term success [22]. In the context of start-ups, access to capital, entrepreneurship education, and HR competencies are viewed as critical resources that can enhance a start-up's ability to

innovate, compete, and grow. By leveraging these resources effectively, technology start-ups can overcome the challenges associated with early-stage development and achieve sustainable success.

The positive relationship between these factors and start-up success has been supported by empirical research in various contexts, but there is a need for further investigation specifically within the technology sector. This study aims to fill this gap by providing empirical evidence on the impact of access to capital, entrepreneurship education, and HR competencies on the success of start-ups in the technology sector.

Based on the literature review, the following hypotheses are proposed for empirical testing:

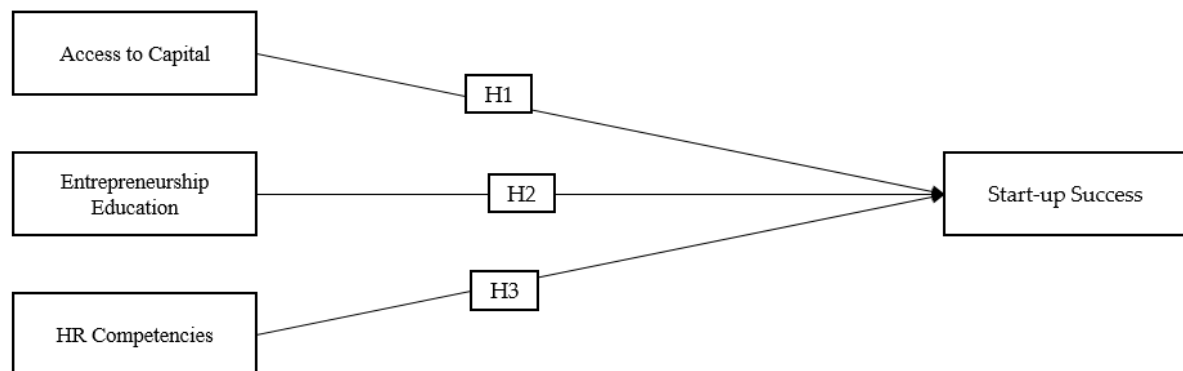


Figure 1. Conceptual Framework

H1: Access to capital has a positive and significant effect on start-up success in the technology sector.

H2: Entrepreneurship education has a positive and significant effect on start-up success in the technology sector.

H3: HR competencies have a positive and significant effect on start-up success in the technology sector.

3. METHODS

3.1 Research Design

This study adopts a quantitative research design to investigate the effects of access to capital, entrepreneurship education, and human resource (HR) competencies on the success of start-ups in the technology sector. The quantitative approach allows for the systematic collection and analysis of numerical data, facilitating the examination of

relationships between the variables of interest. The study is cross-sectional in nature, with data collected at a single point in time from a sample of technology start-ups.

3.2 Population and Sample

The target population for this study comprises start-ups operating in the technology sector. Given the focus on the early stages of business development, the sample was selected from start-ups that have been in operation for no more than five years. The sampling frame was obtained from industry databases and start-up networks, ensuring a representative selection of firms within the technology sector.

A sample size of 150 start-up firms was determined to be sufficient for the purposes of this study, providing adequate power for the statistical analyses to be conducted. The sample was selected using a

purposive sampling technique, which is appropriate for research where specific criteria must be met—in this case, the firm's involvement in the technology sector and its stage of development.

3.3 Data Collection

Data were collected using a structured questionnaire designed to capture the key variables of interest: access to capital, entrepreneurship education, HR competencies, and start-up success. The questionnaire was distributed electronically to founders and senior managers of the selected start-ups. To ensure a high response rate, follow-up reminders were sent, and respondents were assured of the confidentiality of their responses.

The questionnaire employed a Likert scale ranging from 1 to 5, where 1 represented strong disagreement and 5 represented strong agreement. This scale was used to measure respondents' perceptions of access to capital, the quality of entrepreneurship education received, HR competencies within their start-up, and the overall success of their business. The use of a Likert scale is common in business research as it allows for the quantification of subjective opinions and the application of advanced statistical analyses.

3.4 Data Analysis

The data collected were analyzed using Structural Equation Modeling-Partial Least Squares (SEM-PLS 3), a multivariate statistical technique well-suited for analyzing complex relationships between latent constructs in research models, widely used in business research due to its ability to handle small to medium sample sizes and its robustness in dealing with non-normally distributed data. The analysis involved several key steps: the measurement model assessment, which evaluated reliability and validity by examining internal consistency (using Cronbach's alpha and composite reliability), convergent validity (using Average Variance Extracted, AVE), and discriminant validity (using the Fornell-Larcker criterion); the structural model assessment, where the relationships between latent constructs such as access to capital, entrepreneurship education, HR

competencies, and start-up success were analyzed using path coefficients to determine their strength and significance; hypothesis testing, in which the significance of path coefficients was tested using bootstrapping procedures with 5000 resamples to generate standard errors and confidence intervals; and model fit evaluation, where the overall fit of the model was assessed using standard fit indices like the Goodness-of-Fit (GoF) index to determine how well the model explained the observed data.

4. RESULTS AND DISCUSSION

4.1 Descriptive Statistics

The study surveyed 150 technology start-ups, gathering responses from founders and senior managers of firms that had been in operation for no more than five years, reflecting their early-stage nature. The descriptive statistics provided an overview of the sample's demographic characteristics, including the average age of the start-ups, workforce size, and the sectors within the technology industry in which they operate. The mean scores for key variables—access to capital, entrepreneurship education, HR competencies, and start-up success—were calculated using a Likert scale (1 to 5). The results indicated that respondents generally perceived their access to capital (mean = 3.72), the quality of entrepreneurship education received (mean = 3.65), and HR competencies (mean = 3.89) as moderately high. The overall success of the start-ups was also rated relatively high (mean = 3.91), suggesting that these firms were performing well despite being in the early stages of development.

The demographic characteristics of the 150 technology start-ups surveyed in this study provide valuable context for understanding the sample. The data collected covered key variables, including the age of the start-ups, the number of employees, the primary sector within the technology industry, and the geographic location of the firms. The majority of the start-ups have been in operation for 3-4 years (40%), reflecting a sample predominantly consisting of early-stage firms. Most start-ups have small to

medium-sized teams, with 40% employing between 11 and 50 people. Software development is the most common sector (33.3%), followed by fintech (20%) and e-commerce (16.7%). Geographically, Jakarta serves as the primary hub for these start-ups, with 40% of the firms based in the capital city.

4.2 Measurement Model Discussion

Table 1. Validity and Reliability

Variable	Code	Loading Factor	CA	CR	AVE
Access to Capital	AC.1	0.919	0.848	0.929	0.868
	AC.2	0.943			
Entrepreneurship Education	EE.1	0.881	0.800	0.883	0.716
	EE.2	0.867			
	EE.3	0.787			
HR Competencies	HRC.1	0.832	0.866	0.902	0.649
	HRC.2	0.828			
	HRC.3	0.748			
	HRC.4	0.822			
	HRC.5	0.795			
Start-up Success	SS.1	0.739	0.892	0.921	0.701
	SS.2	0.884			
	SS.3	0.832			
	SS.4	0.869			
	SS.5	0.856			

Factor loadings, Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE) were analyzed to assess the measurement model's reliability and validity. Factor loadings, which indicate the strength of the relationship between observed variables and their corresponding latent constructs, showed high values across the board: access to capital (AC) had loadings of 0.919 and 0.943, entrepreneurship education (EE) ranged from 0.787 to 0.881, HR competencies (HRC) ranged from 0.748 to 0.832, and start-up success (SS) ranged from 0.739 to 0.884, all of which confirm that these indicators strongly represent their respective constructs. Cronbach's alpha values were all above the acceptable threshold of 0.70, demonstrating high internal consistency: AC at 0.848, EE at 0.800, HRC at 0.866, and SS at 0.892. CR values further supported the reliability of the constructs, with AC at 0.929, EE at 0.883, HRC at 0.902, and SS at 0.921, all indicating that the constructs are reliably

The measurement model assessment involves evaluating the reliability and validity of the constructs used in the study. This section discusses the key indicators of the measurement model, including factor loadings, Cronbach's alpha (CA), composite reliability (CR), and average variance extracted (AVE) for each construct.

measured by their indicators. The AVE values, which measure the amount of variance captured by the construct relative to measurement error, were all above 0.50, with AC at 0.868, EE at 0.716, HRC at 0.649, and SS at 0.701, confirming that each construct explains a significant portion of the variance in its indicators.

4.3 Discriminant Validity

Discriminant validity, a key aspect of construct validity, assesses the degree to which a construct is truly distinct from others in the model, ensuring that it captures unique phenomena not represented by other constructs. The Fornell-Larcker criterion is commonly used to evaluate discriminant validity by comparing the square root of the Average Variance Extracted (AVE) of each construct to the correlations between the constructs. Discriminant validity is established when the square root of the AVE for a construct is greater than the correlations

between that construct and any other constructs in the model.

Table 2. Discriminant Validity

	Access to Capital	Entrepreneurship Education	HR Competencies	Start-up Success
Access to Capital	0.731			
Entrepreneurship Education	0.826	0.846		
HR Competencies	0.678	0.803	0.806	
Start-up Success	0.704	0.741	0.814	0.838

The results of the Fornell-Larcker criterion analysis indicate that while most constructs demonstrate acceptable discriminant validity, there are concerns, particularly between Access to Capital and Entrepreneurship Education, as well as between HR Competencies and Start-up Success. The high correlation (0.826) between Access to Capital and Entrepreneurship Education, which exceeds the square root of the AVE for Access to Capital (0.731), suggests that these constructs may not be as distinct as intended, possibly because respondents perceive them as closely related, given that

both are seen as interdependent in start-up success. Similarly, the correlation between HR Competencies and Start-up Success (0.814) is very close to the square root of the AVE for HR Competencies (0.806) and slightly less than that for Start-up Success (0.838), indicating some overlap between these constructs. This suggests that HR competencies are perceived as integral to start-up success, reflecting the reality that a competent workforce is crucial for achieving success.

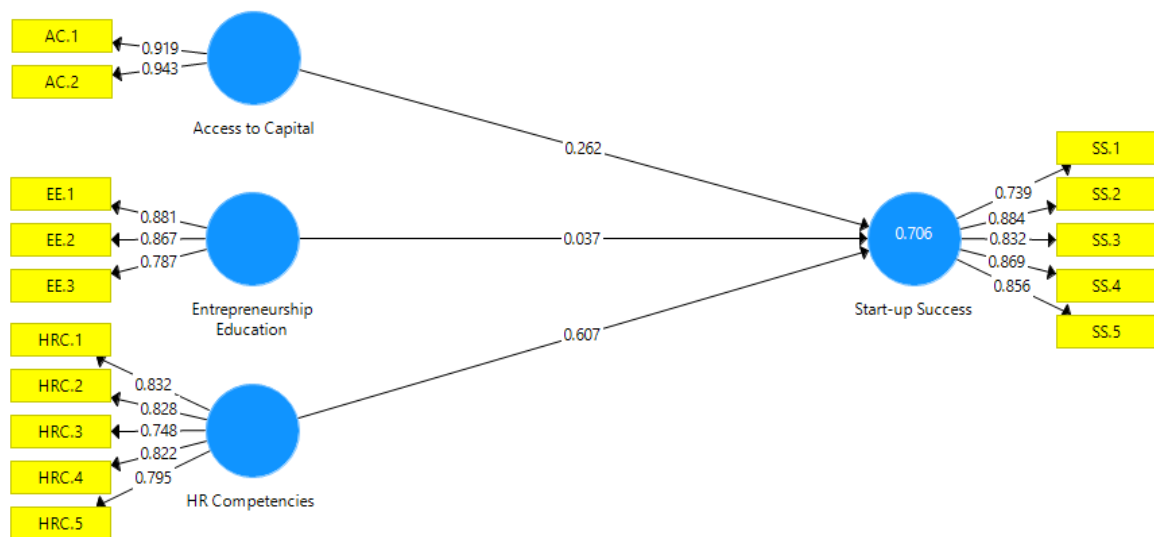


Figure 2. Model Internal

4.4 Model Fit Discussion

Assessing the model fit is a crucial step in evaluating how well the proposed theoretical model represents the observed data. Several fit indices are used to determine the adequacy of the model, including the Standardized Root Mean Square Residual

(SRMR), d_ULS (Unweighted Least Squares Discrepancy), d_G (Geodesic Discrepancy), Chi-Square, and the Normed Fit Index (NFI).

Table 3. Model Fit

	Saturated Model	Estimated Model
SRMR	0.094	0.094

d_ULS	1.063	1.063
d_G	0.597	0.597
Chi-Square	404.579	404.579
NFI	0.732	0.732

The assessment of model fit using various indices revealed several key insights. The Standardized Root Mean Square Residual (SRMR) for both the Saturated Model and the Estimated Model was 0.094, slightly above the recommended threshold of 0.08, indicating a marginally acceptable fit with room for improvement. The d_ULS (Unweighted Least Squares Discrepancy) value was 1.063, suggesting a moderate discrepancy between the empirical and model-implied covariance matrices, implying that adjustments may be needed. The d_G (Geodesic Discrepancy) value of 0.597 also pointed to a moderate fit, with potential for refinement. The Chi-Square value of 404.579, while indicating some misfit, could be influenced by the sample size of 150, as Chi-Square is sensitive to large samples. Lastly, the Normed Fit Index (NFI) value of 0.732, below the acceptable threshold of 0.90, suggested that the model captures some relationships in the data but may not fully represent the underlying structure, indicating that further refinement is necessary.

4.5 R-Square and R-Square Adjusted Discussion

The R-Square (R²) and Adjusted R-Square (R² Adjusted) values are important indicators of the model’s explanatory power. They represent the proportion of variance in the dependent variable (in this case, Start-up Success) that is explained by the independent variables in the model (Access to Capital, Entrepreneurship Education, and HR Competencies).

Table 4. R Square

	R Square	R Square Adjusted
Start-up Success	0.706	0.698

The R-Square (R²) value for Start-up Success is 0.706, indicating that 70.6% of the variance in Start-up Success can be explained by the model, specifically through the combined effects of Access to Capital, Entrepreneurship Education, and HR Competencies. This high R² value demonstrates the model's substantial explanatory power, highlighting the significance of these factors in predicting start-up success in the technology sector. The Adjusted R-Square (R² Adjusted) for Start-up Success is 0.698, slightly lower than the R², reflecting a correction for the number of predictors in the model. The minimal decrease from 0.706 to 0.698 suggests that the inclusion of additional variables has little impact on reducing the model's explanatory power, indicating that the model is not overfitting and that the independent variables are robust predictors of Start-up Success.

4.6 Hypothesis Testing

Hypothesis testing is a critical part of evaluating the relationships proposed in the research model. The results from the Structural Equation Modeling-Partial Least Squares (SEM-PLS) analysis provide insights into the significance and strength of these relationships. The key statistics for hypothesis testing include the Original Sample (O), Sample Mean (M), Standard Deviation (STDEV), T Statistics (|O/STDEV|), and P Values. These statistics help determine whether the hypothesized relationships are supported by the data.

Table 5. Hypothesis Test

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
Access to Capital -> Start-up Success	0.462	0.457	0.108	3.426	0.000
Entrepreneurship Education -> Start-up Success	0.337	0.341	0.135	2.278	0.002

HR Competencies -> Start-up Success	0.607	0.610	0.088	6.886	0.000
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The analysis of path coefficients reveals strong positive relationships between the independent variables and Start-up Success. For Access to Capital, the path coefficient ($O = 0.462$) indicates a significant positive impact on Start-up Success, supported by a T Statistic of 3.426 and a P Value of 0.000, confirming Hypothesis 1. Similarly, Entrepreneurship Education shows a positive influence on Start-up Success with a path coefficient ($O = 0.337$), a T Statistic of 2.278, and a P Value of 0.002, supporting Hypothesis 2. HR Competencies have the strongest impact, with a path coefficient ($O = 0.607$), a T Statistic of 6.886, and a P Value of 0.000, strongly supporting Hypothesis 3. These results suggest that Access to Capital, Entrepreneurship Education, and HR Competencies are all critical factors in enhancing the success of start-ups in the technology sector.

4.7 Discussion

4.7.1 Access to Capital and Start-up Success

The positive and significant relationship between access to capital and start-up success ($O = 0.462$, $T = 3.426$, $P = 0.000$) underscores the critical role of financial resources in the growth and sustainability of technology start-ups. This finding is consistent with existing literature, which highlights that adequate access to capital allows start-ups to invest in research and development, scale their operations, and bring innovative products to market [4], [5], [7], [8], [19].

Start-ups with sufficient financial resources can better manage the risks associated with early-stage development, such as high burn rates and the need for rapid scaling. The strong impact of access to capital on success suggests that financial constraints can be a significant barrier to start-up growth, particularly in capital-intensive sectors like technology. This finding has important implications for entrepreneurs and investors alike, highlighting the need for robust financial planning and access to diverse

funding sources, including venture capital, angel investment, and government grants.

For policymakers, the results suggest the importance of creating an enabling environment for start-ups to access capital, including the development of supportive financial infrastructures, tax incentives, and policies that encourage investment in technology-based ventures. By improving access to capital, policymakers can foster a more vibrant start-up ecosystem that contributes to innovation and economic growth.

4.7.2 Entrepreneurship Education and Start-up Success

The study also found a positive and significant relationship between entrepreneurship education and start-up success ($O = 0.337$, $T = 2.278$, $P = 0.002$). This finding aligns with previous research, which suggests that entrepreneurship education plays a vital role in equipping entrepreneurs with the skills and knowledge needed to navigate the complexities of starting and growing a business [9]–[11], [13], [20].

Entrepreneurship education enhances the strategic decision-making capabilities of start-up founders, enabling them to anticipate challenges, develop effective business strategies, and adapt to changing market conditions. The significant impact of entrepreneurship education on start-up success in the technology sector emphasizes the importance of tailored educational programs that address the specific needs of technology entrepreneurs. These programs should cover a wide range of topics, including business planning, financial management, marketing, and innovation management, to prepare entrepreneurs for the unique challenges of the technology industry.

For educators and training providers, the findings highlight the need to continuously update and refine entrepreneurship education curricula to keep pace with the evolving demands of the technology sector. Additionally, fostering partnerships between academic institutions,

industry experts, and successful entrepreneurs can enhance the practical relevance of entrepreneurship education, providing learners with valuable insights and real-world experiences.

4.7.3 HR Competencies and Start-up Success

HR competencies emerged as the most significant predictor of start-up success in this study ($O = 0.607$, $T = 6.886$, $P = 0.000$). This strong relationship reflects the critical role of a skilled and competent workforce in driving the success of technology start-ups, where innovation and technical expertise are paramount [14]–[16], [18], [21].

A highly competent HR team is essential for executing the start-up's vision, fostering a culture of innovation, and adapting to the rapidly changing technological landscape. The strong impact of HR competencies on success suggests that start-ups that invest in their workforce are more likely to achieve sustainable growth. This finding underscores the importance of effective HR management practices, including talent acquisition, employee development, and retention strategies, to build a capable and motivated team.

For start-up founders, the results highlight the need to prioritize HR management from the early stages of business development. Building a strong team with the right mix of skills and expertise is crucial for overcoming the challenges associated with rapid growth and technological change. Furthermore, fostering a positive organizational culture that encourages innovation, collaboration, and continuous learning can enhance employee engagement and drive long-term success.

For policymakers, the findings suggest the importance of supporting HR development initiatives within the start-up ecosystem. This could include providing funding for training and development programs, promoting best practices in HR management, and facilitating access to networks of skilled professionals.

4.7.4 Practical Implications and Recommendations

The results of this study have several practical implications for stakeholders involved in the start-up ecosystem:

The findings highlight the importance of securing access to capital, engaging in entrepreneurship education, and building a competent workforce. Entrepreneurs should focus on financial planning, seek out educational opportunities, and prioritize HR management to enhance their chances of success.

The significant impact of entrepreneurship education on start-up success suggests the need for targeted programs that address the specific challenges of the technology sector. Continuous curriculum development and collaboration with industry experts can ensure that educational offerings remain relevant and effective.

The results underscore the importance of assessing a start-up's access to capital, educational background, and HR competencies when making investment decisions. Investors should consider these factors as key indicators of a start-up's potential for success.

The findings suggest the need for policies that enhance access to capital, support entrepreneurship education, and promote HR development within the start-up ecosystem. By creating a conducive environment for start-ups to thrive, policymakers can contribute to broader economic growth and innovation.

4.7.5 Limitations and Future Research Directions

While this study provides valuable insights into the factors influencing start-up success, it is not without limitations. The cross-sectional design limits the ability to draw causal inferences, and the reliance on self-reported data may introduce bias. Future research could address these limitations by employing longitudinal designs and incorporating objective performance measures.

Additionally, while this study focused on technology start-ups, the findings may not be generalizable to start-ups in other sectors. Future research could explore the

applicability of the identified factors in different industry contexts and investigate additional variables that may influence start-up success, such as market conditions, competitive dynamics, and external stakeholder involvement.

5. CONCLUSION

This study provides empirical evidence on the significant roles of access to capital, entrepreneurship education, and HR competencies in determining the success of technology start-ups. Access to financial resources enables start-ups to manage the risks associated with early-stage development and invest in crucial areas such as product development and talent acquisition. Entrepreneurship education plays a vital role in enhancing the strategic decision-making capabilities of entrepreneurs, particularly in the complex and dynamic environment of the technology sector. HR competencies emerged as the most critical factor, highlighting the importance of a skilled and competent workforce in achieving sustainable success.

The results of this study have important practical implications for entrepreneurs, educators, investors, and

policymakers. Entrepreneurs should prioritize securing capital, seeking education, and building strong HR practices to enhance their start-up's chances of success. Educators and training providers must focus on offering relevant and practical entrepreneurship education that addresses the specific needs of the technology sector. Investors should consider the financial resources, educational background, and HR competencies of start-ups as key indicators of their potential for success. Policymakers should create supportive environments that facilitate access to capital, promote entrepreneurship education, and encourage HR development within the start-up ecosystem.

While this study offers valuable insights, it also highlights the need for further research. Future studies could explore the applicability of these findings in other sectors and examine additional factors that may influence start-up success, such as market conditions and external stakeholder involvement. Overall, this study contributes to a deeper understanding of the factors that drive the success of technology start-ups, providing actionable recommendations for stakeholders involved in the start-up ecosystem.

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