Decoding Entrepreneurial Intentions Among University Students in the Digital Age: A Machine Learning Approach to Leadership and Attributes

Abstract –   Leadership and personal attributes have significant roles in leading a successful business organization. Meanwhile, how the pattern of leadership and personal attributes contribute to entrepreneurial intention is a new perspective in leadership and entrepreneurship research. To fill the gap and explore the pattern, this research examines the role of leadership and personal attributes in shaping entrepreneurial intention. This research employs a mixed-method approach, combining exploratory analysis and machine learning techniques. Data were collected from 127 entrepreneurial students in West Java, Indonesia. The data were collected using a web-based questionnaire consisting of 38 indicators that reflect the 5 variables (motivation, expectation, risk resistance, negative attitudes, and leadership). The collected data were proceeded using exploratory factor analysis to test the reliability of each indicator and analyzed using a decision tree model to identify critical factors influencing entrepreneurial intention. The research findings reveal that negative attitudes are crucial in determining entrepreneurial intention, followed by motivation and leadership. The study explains how these attributes interact to influence entrepreneurial decisions. This study gives insight into improving the effective development program that fosters the key attributes by reducing negative attitudes. This research contributes to the broader field of leadership and entrepreneurship, offering an understanding of the role of personal attributes and leadership in driving entrepreneurial action.

Keywords: Entrepreneurial leadership, entrepreneurial intention, machine learning, decision tree algorithm.

I. INTRODUCTION

Understanding and implementing effective leadership practices is essential for business organizations to achieve sustainability and long-term success (Nguyen et al., 2021). Effective leadership significantly enhances the organization's financial performance and drives innovation in product development(Son et al., 2020). In addition, the leadership style adopted within an organization plays a critical role; it positively correlates with key business outcomes, such as increased market share and profitability. Additionally, a supportive and empowering leadership style boosts employee satisfaction and commitment, leading to lower turnover rates, higher levels of engagement, and improved overall organizational performance (Kim & Beehr, 2020).

Successful leadership cannot be separated from personal attributes. How a person reaches the environment and expresses their motivation, expectations, risk resistance, and attitudes are part of the personal attributes, including individual values carried by the person in charge. Previous studies on leadership and personal values found that there is a positive relationship between personal values balance and leadership effectiveness (Arieli et al., 2020; Lips-Wiersma et al., 2020). Personal values are what people aspire to and, what individuals endorse for achievement values because they aspire to succeed(Sagiv & Schwartz, 2022).

Developing and starting a new business is a big decision. Both leadership and personal attributes play a role in individual decisions. The literature explores many areas of relationship among leadership, personal attributes, and entrepreneurial intention; Nunfam et al., 2022; Sánchez, 2021). The relationship explored the relationship between leadership and entrepreneurial intention(Sujana et al., 2022), the relationship between leadership and personal attributes(Gardner et al., 2021; Steffens et al., 2021), and the relationship between personal attributes and entrepreneurial intention(Nunfam et al., 2022; Sánchez, 2021). The pattern of how the three aspects relate to each other is underexplored.

This research aims to bridge the literature gaps by exploring the leadership patterns and personal attributes that lead to the intention to start a business.

This research introduces a novel perspective by simultaneously exploring the interplay between leadership, personal attributes, and entrepreneurial intention. Unlike prior research, such as Nunfam et al. (2022), which focuses on how personal attributes drive entrepreneurial intention(Nunfam et al., 2022), or Sánchez (2021), which examines entrepreneurial intention through a psychological lens(Bueckmann-Diegoli et al., 2021), this study explores the interplay between leadership, personal attributes, and entrepreneurial intention as an integrated framework. By simultaneously analyzing the patterns among these three aspects, this research seeks to bridge the gap in the literature and provide a holistic understanding of how leadership and personal attributes shape entrepreneurial intention. This integrative approach enhances theoretical insights and offers practical implications for fostering entrepreneurial leadership. This research will contribute to the development of entrepreneurship development programs. Institutions can consider the proper program to assist their students' businesses. In leadership, this research will contribute to mapping the attributes of leadership that lead individual decisions to start new businesses.

Leadership theory is a nonstatic theory, since theory grows and changes over time(Benmira & Agboola, 2021). Many definitions have been built from time to time, but the same role happens in the definition of leadership. To summarize the definition of leadership, three components that are important and related to leadership: leader, follower, and the context surrounding it(Dinibutun, 2020). From time to time, no literature argues about the necessity of leadership. Supported by empirical evidence, it shows that leadership has its own roles.(Mehmood et al., 2020; Suswati, 2023), shapes(Hensellek et al., 2023;Wu et al., 2021), style(Verma & Kumar, 2022), and ways to influence the organization(Islam & Asad, 2021; Kafetzopoulos & Gotzamani, 2021; Wu et al., 2021) to reach its vision.

The significant roles of leadership in business organizations have been proven. Leadership promotes creativity, psychological safety, innovation, and adaptive culture. Leadership in entrepreneurial firms is positively related to employee creativity, mediated by psychological empowerment and psychological safety.(Mehmood et al., 2020). In entrepreneurial firms, especially small businesses, leadership has a significant role in facilitating the innovation process in their business model, which leads to increasing sales(Colovic, 2022). The leadership style found relates to the organization's ability to be culturally adaptive and plays a significant role in making the business resilient(Madi Odeh et al., 2023).

Leadership and personal attributes are difficult to distinguish. Past research proves that personal attributes are indispensable qualities for a leader(Bass, 2019). Personal attributes encompass a belief system expressed in attitudes, motivation, expectations, and how they deal with risk. These influences by their extensive past experiences shape their action in leading organizations (Sanfilippo et al., 2023). Research on the relationship between leadership and personal attributes examined how the follower received the relationship of both(Gardner et al., 2021; Steffens et al., 2021), identified personal attributes of charismatic leaders(Zhao et al., 2021), and the role of personal attributes of leaders in making changes (Jung et al., 2020).

In the context of business, research has shown that a leader's personal attributes significantly influence public perception of the business's values (Chandler et al., 2023). Entrepreneurial intention is also closely related to personality traits, with gender as a mediating factor (Hossain et al., 2024). Furthermore, passion is a critical element that significantly influences entrepreneurial intention (Ferreira-Neto et al., 2023). While many studies have explored the relationships between variables, examining how one variable influences another, there is a noticeable gap in the literature. Specifically, the authors found no research investigating how leadership and personal attributes play a role in driving the decision to start a business.

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No	Likert Scales	Transformation
1.	1 to 2	Low
2.	3	Moderate
3.	4 to 5	High

II. METHODS

This research explores the pattern of leadership, personal attributes, and entrepreneurial intention. The data was collected from entrepreneurial students from West Java, Indonesia, who take an entrepreneurship program. The Entrepreneurial students were selected as they actively engaged in entrepreneurship programs, making them a relevant population for this study. Their academic training and exposure to entrepreneurial activities equip them with foundational knowledge and experiences, enabling them to provide informed responses regarding leadership, personal attributes, and entrepreneurial intention. The methods used in this study are quantitative research methods and machine learning for advanced data analysis to identify patterns and relationships among the variables.

As the primary data, the questionnaire was built using a Likert scale, containing five scales. The data were collected using a web-based questionnaire consisting of 38 indicators that reflect the 5 variables (motivation, expectation, risk resistance, negative attitudes, and leadership). The data was collected within two months among students from various study programs. About 127 respondents were gathered from 18 to 23; 63% were men, and 37% were women. The respondents were selected through purposive sampling, targeting students enrolled in Entrepreneurship programs in West Java, Indonesia. These students were chosen due to their active participation in structured entrepreneurial education, which aligns with the study's objectives of examining leadership, personal attributes, and entrepreneurial intention. Exploratory Factor Analysis was employed for each variable to test each indicator's reliability and explain that variable. Cronbach's alpha was used to test the reliability

Table 1 Scale transformation

No	Likert Scales	Transformation

For the next analysis, the research instrument was transformed into a dataset to process data and build models for implementing a decision tree algorithm on a RapidMiner. The average value of the indicators for each variable is taken to get a score from each respondent on each variable. The response scales (1 to 5) of each variable were transformed into low, moderate, and high levels (see Table 1), prepared for the next process using machine learning. After being transformed, the data became a dataset ready to be used. In the dataset, each existing variable becomes an attribute of the dataset. The dataset consisted of six attributes: motivation, expectation, risk resistance, negative attitudes, leadership, and gender. The label to predict was the intention to start a business. The result was validated using performance measurement to measure the accuracy of the prediction.

III. RESULTS AND DISCUSSION

Exploratory factor analysis was used to test the indicators of each variable to determine their validity. The tests used were KMO and Bartlett's test, and commonalities. Each variable was tested using KMO and Bartlett's test, and anti-image matrices.

Table 2. KMO Values Result

Variable	KMO		
	Result 1	Result 2	Result 3
Leadership	.930	.917	
Motivation	.766	.500	
Expectation	.764	.746	
Risk resistance	.643	-	
Negative attitudes	.875	.882	.875

KMO and Bartlett's test and anti-image matrices were used to check the adequacy of the indicator for conducting factor analysis. KMO values range from 0 to 1, with values above 0.60 indicating adequate sampling for factor analysis. At the same time, Bartlett's test evaluates whether the correlation matrix significantly deviates from an identity matrix, suggesting that the variables are correlated

sufficiently to warrant further analysis(Eze et al., 2021; Yusof et al., 2020). Table 2 shows that each variable has high KMO values, with ranges of KMO from 0.64 to 0.930, indicating that the indicator of the variable is adequate for factor analysis(Yusof et al., 2020). The importance of these tests in validating constructs within educational contexts further supports the notion that high KMO values are indicative of data suitability for EFA(Hidayati et al., 2018).

The chi-square values (see Table 3) range from 137 to 925, and significant values <0.05 indicate a significant correlation; thereby, the data is suitable for factor analysis. This result is in line with the findings of Eze et al., who demonstrated that significant results in Bartlett's test confirm the appropriateness of factor analysis(Eze et al., 2021).

Table 3. Result of Chi-Square Values

Variable	Chi-Square		
	Result 1	Result 2	Result 3
Leadership	925.133	768.260	
Motivation	137.464	17.589	
Expectation	315.574	288.749	
Risk resistance	177.334	-	
Negative attitudes	589.315	505.460	446.229

Table 4. Results of Communalities of Leadership, Motivation, and Expectation

Indicator	Leadership		Motivation		Expectation	
	R1	R 2	R 1	R 2	R1	R 2
1	.663	.662	.437	-	.670	.713
2	.638	.633	.305	-	.282	-
3	.540	.562	.406	-	.558	.558
4	.701	.715	.525	.681	.692	.691
5	.589	.594	.528	.681	.622	.620
6	.499	-	.378	-	.568	.581
7	.510	.512			.559	.570
8	.607	.609			.723	.733
9	.559	.579				
10	.631	.630				
11	.533	.538				
12	.496					

The results of the analysis factor for leadership, motivation, expectation, risk resistance, and negative attitude are shown in Table 3. The result of communalities extraction represents the proportion of each variable that can be explained by the factors extracted. A variable can explain a factor if its extraction value is greater than 0.50(Zhou et al., 2022). Extraction is carried out several times by removing values less than 0.50. The iterative process of removing variables with lower communalities ensures that the final model retains only the most relevant indicators(Melnyk et al., 2022). Table 4 shows the extraction values on leadership, motivation, and expectation, while the results on risk resistance and negative attitudes are shown in Table 5.

Table 5. Result of Communalities of Risk Resistance and Negative Attitudes

Indicator	Risk Resistance	Negative attitudes		
		R1	R 2	R 3
1	.855	.455	-	-
2	.828	.520	.456	-
3	.672	.672	.675	.650
4	.701	.589	.630	.670
5	.657	.736	.763	.773
6		.760	.791	.805
7		.785	.813	.843

The component transformation matrix ensures that each indicator is correlated with the factor it forms. This ensures that each indicator is right for the variable being searched for. The test results show five groupings where several indicators are grouped with indicators from other variables. Through analysis and understanding of the context of the indicators and variables formed, the renaming is carried out according to the original variables. The complete results of the variable operationalization (based on the indicator result) can be seen in Table 6.

Table 6. Variable and Description

Description/operationalization variable	Attributes
Determination and persistence	Leadership
Confidence	
Being good with people	
Interest and energy	
Creativity and ability	
Intelligence	
Honesty	
Sensitivity	
Commitment	
Acts according to plans	
Doubt that they will ever have a business degree to start their own business	Negative Attitudes

Doubt that they will ever have enough money to start their own business
Doubt that they will ever have enough good communication skills to start their own business
Doubt that they will ever have proper knowledge about money to start their own business
Doubt that they will ever have sufficient management skills to start their own business

A business degree is needed to start a business	Expectation
A lot of money needed to start a business	
Have a career that uses the skills and abilities fully	
could make lots of money	
Could work the hours that they want	
Could earn a living doing something that they enjoy	
It's important to put ideas into practice	Motivation
It's important to earn a living doing something that they enjoy	
Starting a business involves taking a risk.	
Starting a business could put the ideas into practice.	
Starting a business could have the control that comes from being one's own boss	
Need good communication skills to start own business	Risk
Need proper knowledge about money to start own business	
Need management skills to start own business	

The Cronbach's alpha test was employed to ensure that all the questionnaire indicators were reliable. The Cronbach's alpha test results show values > 0.60, which means that the indicators are reliable in explaining the research variable. The result of the reliability test is shown in Table 7:

Table 7. Reliability Result of each variable

No	Variable	Cronbach's Alpha	N of Items
1	Leadership	.926	10
2	Motivation	.736	5
3	Expectation	.771	6
4	Risk resistance	.761	3
5	Negative attitudes	.915	5

The final indicator and variables were transformed and prepared for final analysis using machine learning. Machine learning was used to find the pattern of aspects that lead to entrepreneurial intention. The attributes involved in the analysis are leadership, motivation, expectation, risk resistance, negative attitudes, and gender. The label for this model was the intention of starting a business.

Figure 1. Snapshot of dataset

At the modeling step, this research used a decision tree algorithm to process the dataset. Decision trees are used in various fields, such as machine learning. A decision tree is a powerful and popular approach in data mining to finding useful patterns(Priyanka & Kumar, 2020).

Information gain was used as the splitting criteria with simple pruning. This approach is the most effective method for small datasets(Taha Jijo & Mohsin Abdulazeez, 2021). Tree pruning is applied in the decision trees to reduce the tree size by removing the branches. The pruning is applied to decrease the complexity of the tree.
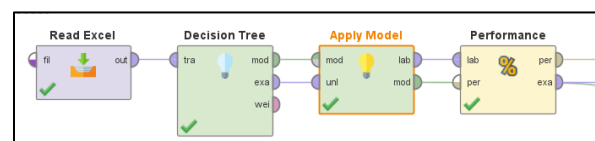

Figure 2. RapidMiner's process

The process on RapidMiner involves four operators: Read Excel, Decision Tree, Apply Model, and Performance. All the operators should connect in certain rules to point to the right to process the analysis.

Negative attitudes = high
| Motivation = high
| | Risk resistance = high
| | | Expectation = high
| | | | Leadership = high

| | | | | Gender = Female: Intend {Undecided=5, Intend=6, DN Intend=0}
| | | | | Gender = Male: Undecided {Undecided=12, Intend=8, DN Intend=0}
| | | | Leadership = moderate: Intend {Undecided=5, Intend=8, DN Intend=0}
| | | Expectation = low: Intend {Undecided=0, Intend=1, DN Intend=0}
| | | Expectation = moderate: Undecided {Undecided=4, Intend=1, DN Intend=0}
| | Risk resistance = moderate: Intend {Undecided=0, Intend=3, DN Intend=0}
| Motivation = moderate: Undecided {Undecided=4, Intend=0, DN Intend=0}
Negative attitudes = low
| Leadership = high: Intend {Undecided=0, Intend=21, DN Intend=0}
| Leadership = low: Undecided {Undecided=1, Intend=1, DN Intend=0}
| Leadership = moderate
| | Risk resistance = high
| | | Expectation = high: Intend {Undecided=1, Intend=2, DN Intend=0}
| | | Expectation = moderate: Undecided {Undecided=1, Intend=0, DN Intend=0}
| | Risk resistance = moderate: Intend {Undecided=0, Intend=1, DN Intend=0}
Negative attitudes = moderate
| Expectation = high
| | Leadership = high
| | | Gender = Female
| | | | Motivation = high: Intend {Undecided=5, Intend=7, DN Intend=0}
| | | | Motivation = moderate: Undecided {Undecided=1, Intend=0, DN Intend=0}
| | | Gender = Male: Intend {Undecided=1, Intend=8, DN Intend=1}
| | Leadership = low: Undecided {Undecided=2, Intend=2, DN Intend=0}
| | Leadership = moderate: Undecided {Undecided=3, Intend=1, DN Intend=0}
| Expectation = low: Intend {Undecided=0, Intend=2, DN Intend=0}
| Expectation = moderate
| | Risk resistance = high
| | | Gender = Female: Undecided {Undecided=2, Intend=0, DN Intend=0}
| | | Gender = Male
| | | | Leadership = high: Undecided {Undecided=2, Intend=1, DN Intend=0}
| | | | Leadership = moderate: Intend {Undecided=0, Intend=1, DN Intend=0}
| | Risk resistance = moderate: Undecided {Undecided=2, Intend=0, DN Intend=1}

Figure 3. Decision tree result

The decision tree results show that the rote node of the tree has a negative attitude. This indicates that negative attitudes are the most crucial factor significantly influencing entrepreneurial intention. The negative attitude as the rote node split into three branches (high negative, low negative, and moderate attitudes).

In high negative attitudes, motivation, risk resistance expectation, and leadership have roles that influence intention. In the high condition of negative attitude, the motivation branch is further split. This shows that motivation is important for those who with a highly negative attitude. Risk resistance frequently appears and affects the outcome, especially in certain conditions while negative attitude and motivation are high. Expectation and leadership refine the outcome, followed by gender.

In low negative attitudes, leadership plays a significant role in influencing the outcome. In certain conditions, when the negative attitude is low, leadership leads to clear entrepreneurial intention.

In moderate negative attitude, expectation, leadership, and gender play roles that influence the outcome. Leadership and gender in moderate negative attitude are important for entrepreneurial intention.

Based on the result, the decision tree starts with a negative attitude as the rote node; this indicates that the most crucial factor is a negative attitude. Other critical factors are Motivation and leadership. Motivation is the next important aspect influencing the tree's route under high negative attitudes. This suggests that individuals with high negative attitudes have considerably different entrepreneurial intentions depending on their motives. While leadership appears frequently and multiple times across the different branches. Under low negative attitudes, leadership directly affects results; while under high and moderate negative attitudes, it further refines forecasts.

Leadership plays a significant role in entrepreneurial intention among students (Akbari et al., 2021; Hoang et al., 2021). Moreover, leadership appears frequently and plays a major part in the decision tree; it is important in forecasting the intention to start a business. Its strong influence is demonstrated by the fact that it is utilized to partition the data several times among different branches.

People's decisions to launch a business are significantly influenced by leadership, particularly when taken into account in conjunction with other elements like unfavorable attitudes and expectations. Moreover, the impact of leadership is seen in a range of circumstances, encompassing elevated, lowered, and somewhat negative attitudes, underscoring its significance in diverse contexts. Compared to factors like anticipation, motivation, and risk aversion, leadership consistently has a greater impact.

The accuracy of this prediction model is 74.02%. this shows that the prediction model is effective and reliable in most cases. This model can correctly predict entrepreneurial intentions three-quarters of the time. The performance of this model still needs improvement. especially in predicting individuals who do not intend to start a business (DN Intent). To be able to predict accurately, with a better level of prediction, further improvements are still needed.

The results obtained in the prediction model with decision trees in this research can be implemented in entrepreneurial study programs. The research found that three significant factors have to be considered to boost entrepreneurial intention; the study program can build up the right strategic planning. Programs should provide certain programs and entrepreneurial ecosystems that can boost the motivation of the students. Because of the critical role of leadership directly and indirectly to entrepreneurial intention, programs should intensively grow the leadership of the students. Regarding the negative attitude as the most critical factor, creating a support system to minimize will help student lower their negative attitude level.

IV. CONCLUSION

Effective leadership and personal attributes are essential in leading business organizations to success(Errida & Lotfi, 2021; Ghorbani, 2023). To support entrepreneurial firms, the personal attributes and leadership of the entrepreneurial leader drive the entrepreneurial intention to start the business(Schiuma et al., 2022). This study explores the pattern of leadership and personal attributes that lead to entrepreneurial intention. This research collected data from an entrepreneurial program designed to launch new entrepreneurs. Using the Likert scale, the questionnaire consists of six attributes: motivation, expectation, risk resistance, negative attitudes, leadership, and gender(Walk, 2023). The 127 collected questionnaires proceeded to reliability using Cronbach's Alpha and validity of every indicator that belongs to the factor used in exploratory factor analysis(Shrestha, 2021).

The valid indicators of the factors are transformed into a dataset for machine learning analysis using a decision tree algorithm. The result shows that the accuracy of this prediction model is 74.02%. This indicates that the prediction model is effective and reliable in most cases(Chen et al., 2018). the decision tree starts with a negative attitude as the rote node; this indicates that the most crucial factor is a negative attitude(Frosst & Hinton, 2017). Other critical factors are motivation and leadership. The frequent appearance of leadership as a critical factor in the decision tree highlights its importance in fostering entrepreneurial intention, underscoring the need for educational programs to cultivate leadership skills among aspiring entrepreneurs (Charbuty et al., 2021); it is an important component in forecasting the intention to start a business. The research found that three significant factors have to be considered to boost entrepreneurial intention: reducing negative attitudes, and leveling up motivation, and leadership. The study program can build up the proper strategic planning by implementing this research result. This research can contribute to the leadership and entrepreneurship research field to help understand more about the patterns related to personal attributes and entrepreneurial intention.

The limitations of this research are, in particular, the sample size and geographical scope. These are critical factors that can significantly affect the generalizability of the findings. In the context of entrepreneurship program students, the narrow focus on this

specific group may lead to results that do not apply to a broader audience. This concern is echoed in the literature, emphasizing the importance of diverse samples to enhance the validity and applicability of research outcomes. For instance, Williamson discusses innovative strategies to increase sample size and diversity, highlighting that broader participant inclusion is essential for improving replicability and generalizability in research(Williamson, 2023). Furthermore, a limited geographical focus can obscure the understanding of phenomena at more localized levels, suggesting that findings from neighborhood-level studies may not reflect broader state or national trends (Campbell et al., 2019). Future research should address these limitations by expanding the sample size and including a more varied demographic across different regions and cultural contexts. This approach aligns with previous research which advocates for utilizing diverse sampling methods to ensure that research captures a wide range of perspectives and experiences (Miller et al., 2020). Additionally, another research discussed the implications of small sample sizes in their research, indicating that smaller samples can lead to overestimated results, reinforcing the need for larger, more representative samples to draw accurate conclusions(Ayeni et al., 2018). Finally, comparative studies across different regions, industries, and educational levels could provide deeper insights into the pattern.

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