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Strengthening the entrepreneurial ecosystem through innovation: A case study of Pasundan University

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Abstract

This study explores the entrepreneurial ecosystem's influence on fostering innovation among students at the Faculty of Social and Political Sciences, Pasundan University. It aims to identify how material, social, and cultural attributes within the ecosystem impact student innovation. A quantitative approach was employed, utilizing questionnaires distributed to 386 students who had taken entrepreneurship courses. Path analysis was conducted to evaluate the relationships between ecosystem dimensions and innovation. The results reveal that the entrepreneurial ecosystem positively impacts innovation. Material, social, and cultural attributes significantly contribute to fostering innovative capacities, with cultural attributes exerting the strongest influence. This underscores the importance of a supportive environment in promoting entrepreneurial initiatives and creative thinking. Strengthening entrepreneurial ecosystems within universities is vital for cultivating innovation. The interaction of material, social, and cultural attributes fosters a conducive environment for developing student entrepreneurial potential. Institutions should prioritize policies that enhance infrastructure, mentorship, and entrepreneurial culture. These include developing business incubators, increasing access to mentors, and fostering a supportive cultural environment that encourages entrepreneurial pursuits. This approach ensures long-term sustainability and competitiveness for students and universities in the global economy.

Keywords: Business incubators, Cultural attributes, Entrepreneurial ecosystem, Higher education, Student entrepreneurship, Sustainability, Global economy.

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1. Introduction

Based on statistical data from 133.94 million workers, 6.87 million of them are unemployed with an educational background. They are just waiting for offers from the government and private sector without the desire to become entrepreneurs. Therefore, one way to overcome unemployment is through entrepreneurship. The role of universities is very important in creating prospective entrepreneurs because they provide entrepreneurship education programs [1]. In conventional times, the main mission of universities was to train knowledgeable workers, conduct research, and disseminate knowledge (the first and second missions). However, in modern times, with high autonomy, universities are encouraged to become institutions based on entrepreneurship, innovation, and creativity, known as the entrepreneur university model [2]. Currently, entrepreneurship is a common subject in universities [3]. Entrepreneurship is a nationwide phenomenon that encompasses more than just the establishment of new companies in the market [4]. At the beginning of the academic revolution, research was stated as an academic function separate from teaching. However, since its emergence, economic development has been incorporated as an extra role of an entrepreneurial university [5]. Instead of contributing to environmental deterioration and socioeconomic inequity, entrepreneurship can help address these issues [6]. Entrepreneurial universities can bridge innovation and entrepreneurial ecosystems [7]. Definitions of entrepreneurial ecosystems vary widely, but essentially, ecosystems are becoming more popular as a means of understanding the context of entrepreneurship at the macro level of an organizational community. They are made up of all the interdependent actors and factors that allow and restrict entrepreneurship within a specific territory [8]. They emphasize the combination or interaction of different elements through networks that produce cultural values that can support entrepreneurial activities [9]. The entrepreneurial ecosystem in higher education has a significant role in efforts to encourage innovation, entrepreneurship, and economic development.

Various components of the entrepreneurial ecosystem include educational programs [10], the university-based entrepreneurship education ecosystem [11], adequate institutional infrastructure, support structures, and culture [8]. The trend to achieve an innovation ecosystem uses main methods like technology transfer offices (TTO), launch labs, fab labs, makerspaces, hack labs, accelerators, incubators, and makerspaces. Therefore, innovation mechanisms and university ecosystems, especially for increasing innovation, are important, particularly in the industry [12]. Entrepreneurial ecosystems have an important role in increasing innovation [13]. The role of innovation is crucial in creating niche markets and profitable opportunities [14]. This is achieved through various strategies and mechanisms that enhance the growth and sustainability of new businesses. For example, start-ups, despite facing various challenges such as limited resources and high failure rates, can achieve competitive advantages when innovation is utilized [15], improving international performance, and encouraging open innovation processes [16]. The interaction demonstrates the significant role that entrepreneurial players play as catalysts for innovation among the components of the entrepreneurial ecosystem [16]. To address the study questions, we conducted quantitative research by distributing questionnaires to 384 students. This study presents the influence of the entrepreneurial ecosystem and innovation on students. These findings reinforce that innovation can be improved by building an entrepreneurial ecosystem that aligns with the findings. In this research, we want to know the following: (1) Do material attributes influence innovation? (2) Do social attributes influence innovation? (3) Do cultural attributes influence innovation? (4) Does the entrepreneurial ecosystem influence innovation? Next, we will explain the literature review, methodology, and discussion of results and conclusions.

2. Literature Review

2.1. Basic Concepts of Entrepreneurship

The definition of entrepreneurship is being proactive, creative, and willing to take risks. Innovators will act on their ideas. This proactive nature is carried out, and this is an entrepreneurial trait. In other words, entrepreneurial behavior will produce innovation. Another definition states that becoming an entrepreneur involves one's enthusiasm, actions, and capability in managing business activities that lead to efforts to find, create, and apply new ways of working, technology, and goods by boosting productivity in the context of improved customer service and higher revenue [17]. With entrepreneurship, new business opportunities will open up in various regions and strengthen the market, prompting policymakers to realize the importance of entrepreneurship, which is followed by the development of various entrepreneurship policies and their promotion [18]. The fast-paced period of today requires organizations to adjust quickly to survive and achieve sustainability over the long run. The notion of entrepreneurial competence offers several approaches to addressing volatility, uncertainty, complexity, and ambiguity (VUCA) in entrepreneurial activity [19].

The effects of entrepreneurship on management and organizational execution increase competition. Organizations must ensure that resources are integrated and deployed correctly in response to environmental changes [20]. The important role of entrepreneurship lies in the ability to drive the progress of a country's growth. An entrepreneur will consider and act in a manner that can identify and utilize prospects in their surroundings to introduce novel concepts, goods, procedures, and advancements in marketing [21]. Therefore, in the fourth industrial revolution, entrepreneurship-related skills are essential for business development [22].

2.2. Entrepreneurial Ecosystem Concept

The entrepreneurial ecosystem (EE) is defined as a dynamic exchange of entrepreneurial mindsets, capabilities, and goals that allocate resources by starting and running new businesses [23]. Recent studies emphasize the function of entrepreneurship ecosystems in shaping innovative outcomes. For instance [24], it has been highlighted that digital entrepreneurial ecosystems accelerate innovation processes, particularly in technology-driven sectors. Similarly, Kruger and Steyn [25] discuss the development of breakthrough innovation capabilities within university ecosystems, emphasizing the importance of infrastructure, mentorship, and technology transfer offices. They outline seven critical forms of capital—

human, financial, network, cultural, institutional, physical, and intellectual—needed for thriving entrepreneurial ecosystems [26]. They argue that these interconnected elements foster innovation and entrepreneurial success. In addition [27], it has been identified that sustainable entrepreneurship is heavily influenced by ecosystem components such as market access, policy frameworks, and entrepreneurial networks.

The entrepreneurial ecosystem approach provides a framework for conducting empirical exploration of entrepreneurial economic systems as well as the extent to which economic systems generate entrepreneurship as a systemic emergent characteristic [28]. With the existence of an entrepreneurial ecosystem, it shows a continuum of regions with high entrepreneurial growth. In the academic world, this view refers to the entrepreneurial ecosystem as a community that has interests in its environment to support each other in establishing and producing new businesses in an area. Many enthusiasts in academic and political circles have shown significant interest in this idea. The area of the business owner ecosystem still requires a systematic, explicit, and thematically fragmented pattern with hazy distinctions; therefore, it is difficult to understand its structure as well as its influence on entrepreneurial procedures. Although this ecosystem appears as a worldwide occurrence, research is mostly inert and focused in the central government [29].

Entrepreneurship ecosystems must be built by those with sufficient support networks, institutional infrastructure, and a culture that supports and enhances self-efficacy and entrepreneurial aspirations of students [8]. An entrepreneurial ecosystem is "an institutionally embedded dynamic interaction of entrepreneurial attitudes, capabilities, and aspirations by individuals that drives the allocation of resources through the creation and operation of new ventures"[23]. Three sets of supporting entrepreneurial ecosystem characteristics strengthen each other:

- Material attributes (policies, universities, infrastructure, open markets, support services)
- Social attributes (networks, mentors and role models, employee talents, investment capital)
- Cultural attributes (supportive culture, history of entrepreneurship)

Feld and Hathaway [30] state that a thriving entrepreneurial ecosystem requires seven forms of capital: intellectual (ideas, knowledge, etc.); people (talents, skills, diversity, etc.); financial (revenue, financing, etc.); network (connectedness, relationships, etc.); culture (attitudes, history, love of place, etc.); physical (quality of place, infrastructure, etc.); institutional (legal system, market stability, etc.). Therefore, although the steps below focus more on actors (who and where they are, what they do, etc.), it is crucial to consider these "factors." They also have a spatial dimension and can be mapped, such as land zoning or public transport routes [31].

2.3. Basic Concepts of Innovation

Innovation is integral to entrepreneurship and is defined as the process of creating new products, processes, or organizational models that improve efficiency and address emerging market needs [32]. Recent research by Thirumalesh Madanaguli, et al. [12] underscores the role of innovation in helping startups penetrate niche markets and create competitive advantages. Additionally, Chaudhary, et al. [13] explore how entrepreneurial ecosystems serve as catalysts for innovation, revealing the importance of collaboration between universities, government bodies, and private organizations in fostering innovative ventures. The relationship between entrepreneurial ecosystems and innovation has been further elaborated by Chaudhary, et al. [13], who argue that cultural and social forces within ecosystems significantly shape the innovative capabilities of entrepreneurs. Their findings align with the notion that a robust ecosystem, supported by accelerators, incubators, and mentorship, can enhance the innovative capacity of startups and university-led ventures.

Innovation is “the process of learning and discovery about new products, new production processes, and new forms of economic organization”[32]. Innovation and creativity are key elements that differentiate and win competition in an ever-growing global market [33]. Innovation is the propensity to enhance novel components or combinations of earlier technology, goods, or management techniques applied to fresh information [34]. Innovation indeed has an essential impact on companies in the industry [12]. Entrepreneurs are helped by innovation in creating market niches and profitable opportunities. For example, startups founded on business concepts offer cutting-edge goods or services that are impossible to imitate. Effective use of innovation will strengthen startups and small companies so that they can increase competitive pressure on large companies [31].

Adopting an understanding diffusion viewpoint to examine how investment funds based on patents support innovation in entrepreneurial environments, the writers stress the importance of funding at the early stages of technology development. A study in Africa shows how innovation can be influenced by entrepreneurial ecosystems. The results highlight the importance of family ties, market accessibility, and resources. It is hypothesized how innovation contributes to the entrepreneurial ecosystem that generates successful entrepreneurship [13].

In summary, current research reinforces the significance of entrepreneurial ecosystems in promoting innovation, particularly through the integration of material, social, and cultural attributes. Universities play a pivotal role in this dynamic by serving as hubs for innovation and entrepreneurship. However, further exploration is needed to understand the causal mechanisms linking ecosystem components and innovation outcomes.

Based on the problem statement and literature review, this article concludes the following hypotheses:

H_1: Material attributes have a positive and significant influence on innovation.

H_2: Social attributes have a positive and significant influence on innovation.

H_3: Cultural attributes have a positive and significant influence on innovation.

H_4: The entrepreneurial ecosystem has a positive and significant influence on innovation.

3. Methodology

3.1. Data Collection

This study collected data through structured questionnaires distributed to 386 students at the Faculty of Social and Political Sciences, Pasundan University. The questionnaires focused on measuring three dimensions of the entrepreneurial ecosystem—material, social, and cultural attributes—and their impact on innovation. Respondents were selected based on their enrollment in entrepreneurship courses, ensuring their familiarity with the subject.

3.2. Path Analysis

Path analysis, a statistical technique used to evaluate causal relationships among multiple variables, was employed to analyze the data. This method estimates the direct, indirect, and total effects of independent variables (e.g., material, social, and cultural attributes) on the dependent variable (innovation). Unlike regression analysis, which examines only direct effects, path analysis provides a more comprehensive view by modeling interdependent relationships among variables.

3.3. Novelty in Approach

This study differs from past research by utilizing path analysis to quantitatively examine the dimensions of the entrepreneurial ecosystem and their individual and collective influence on innovation. While earlier studies have predominantly relied on qualitative methods (e.g., interviews, case studies) or descriptive statistics, this study provides empirical evidence of causal pathways. For example, Gómez, et al. [35] focused on qualitative insights into entrepreneurial ecosystems, while Kruger and Steyn [25] examined innovation within ecosystems using regression-based methods. By adopting path analysis, this study captures the interconnected effects among the attributes of the ecosystem, offering a more nuanced understanding of how they collectively drive innovation.

3.4. Instrument

The primary data collection instrument was a structured questionnaire designed to measure the dimensions of the entrepreneurial ecosystem (material, social, and cultural attributes) and their impact on innovation. The questionnaire consisted of 19 items for the independent variable (entrepreneurial ecosystem) and 8 items for the dependent variable (innovation). Each item was rated on a Likert scale, capturing the degree to which respondents agreed with statements about their experiences and perceptions.

To ensure the instrument's validity, a validity test was conducted using the Pearson Product Moment correlation, revealing that all items were valid ($r > 0.098$). Reliability was assessed using a split-half method, and the results demonstrated high reliability for both the entrepreneurial ecosystem (Cronbach's Alpha = 0.815) and innovation (Cronbach's Alpha = 0.885). These results indicate the instrument's consistency and ability to accurately measure the intended variables.

3.5. Sampling

The study targeted students from five study programs—International Relations, Public Administration, Social Welfare, Business Administration, and Communication Studies—within the Faculty of Social and Political Sciences at Pasundan University. A total of 5,892 active students were identified as the population. Using the Slovin formula with a 5% margin of error, the sample size was calculated to be 386 respondents, ensuring a representative sample. A technique of stratified random sampling was applied to ensure proportional representation from each study program. Questionnaires were distributed online via Google Forms, providing convenience for respondents and maximizing participation. The inclusion criteria required that students had completed entrepreneurship courses, ensuring their familiarity with entrepreneurial concepts and experiences relevant to the research.

Table 1.
Entrepreneurship ecosystem at the university level.

Variable	Sub variable	Condition
Entrepreneurial entrepreneurship		Quite good
	Material attribute	Quite good
	Social attribute	Good
	Culture attribute	Good
Innovation		Quite good

4. Results and Discussion

4.1. Results

From the score data on respondents' answers to the variable, Table 1 shows that for the Faculty of Social and Political Sciences of Pasundan University students, the entrepreneurship ecosystem is quite good, with positive social and cultural attributes. This indicates that social attributes, including mentors on campus, already exist, even though their number is limited. The talent for entrepreneurship is present among students; however, it still needs to be encouraged and strengthened, including the ability to invest in their businesses. As for the cultural attributes, the appreciation for innovation among start-ups has begun to take shape, although it still requires encouragement. Additionally, the culture for fostering a resilient character still needs strengthening.

Validity and reliability tests are fundamental in evaluating instruments as tools in this research. Validity tests assess the extent to which the instruments used are valid for measuring variables, while reliability tests evaluate the level of reliability of research instruments.

Testing research instruments is crucial before conducting the research, as it aims to determine whether the instrument meets the requirements in terms of validity and reliability. The research questionnaire was organized into two groups according to the number of research variables. The total number of items is 19 statement items. The questionnaire used to measure variables consists of the entrepreneurship ecosystem variable (X), which is divided into three dimensions: material attributes (X1), social attributes (X2), and cultural attributes (X3). The dependent variable is the innovation variable (Y). All questionnaire statements are measured on an ordinal scale and arranged in Likert scale dimensions. The high or low validity of the instrument indicates the extent to which the data collected is consistent with the description of the variable in question [36]. The testing tool used is the Pearson Product Moment correlation formula [37].

4.1.1. Decision Rules

The calculated r value is then compared with the r table value at a certain level of α and degrees of freedom of n-2. The decision rule is as follows:

a. If r count > r table, then the measuring instrument used is valid.

b. If r count < r table, then the measuring instrument used is invalid.

To test the validity of each item, the scores on the item in question are correlated with the total score. The item score is the value. Researchers can replace or revise the items in question based on this information. For researchers who wish, testing of items can be done by correlating the items with the total score on the dimension or dimensions. The results of the validity test on the entrepreneur ecosystem variable (X) are as follows:

Table 2.
Entrepreneur ecosystem variable validity test results (X).

Item	r	r table	Decision
1	0.699	0.098	Valid
2	0.621	0.098	Valid
3	0.694	0.098	Valid
4	0.670	0.098	Valid
5	0.261	0.098	Valid
6	0.579	0.098	Valid
7	0.552	0.098	Valid
8	0.674	0.098	Valid
9	0.597	0.098	Valid
10	0.625	0.098	Valid
11	0.518	0.098	Valid

Based on Table 2, the instrument test for the entrepreneur ecosystem variable shows that all statements are valid, allowing all data to proceed to the following analysis. The validity test for variable Y (innovation), which consists of 8 statement items, is also valid. The calculation results are explained in the following table:

Table 3.
Variable Y validity test results (Innovation).

Item	r	r table	Decision
12	0.550	0.098	Valid
13	0.806	0.098	Valid
14	0.782	0.098	Valid
15	0.804	0.098	Valid
16	0.856	0.098	Valid
17	0.799	0.098	Valid
18	0.597	0.098	Valid
19	0.815	0.098	Valid

An item is valid if the r value, or correlation value, between the item score and the total shows a significant coefficient. It is considered significant if the r table value of the item is smaller than the calculated r value. The table value refers to the r table for product-moment correlation and is determined by the values a = 0.05 and n = 384. Based on these calculations, the table value is 0.098; if there is an invalid item statement, the data obtained cannot be used for further analysis.

After testing the validity, carry out a reliability test of the measuring instrument. Reliability testing aims to show the extent to which a measurement result is relatively consistent if repeated two or more times. In other words, reliability is an index that indicates the extent to which a measuring instrument is trustworthy or reliable if it is used twice or more to measure the same phenomenon, and the measurement results obtained are relatively consistent.

Each instrument should be able to provide consistent measurement results so that the results can be trusted only if relatively similar results are obtained over several measurements on the same group of subjects, provided that the dimensions measured within the subject have not changed. To calculate the reliability coefficient, the split-half technique is used for analysis. Based on the results of data calculations using this formula, the reliability coefficient decision for each variable is obtained as follows:

Table 4.
Research instrument reliability test results.

Number	Research variable	Reliabilities	*) Reference	Decision
1	Entrepreneurial ecosystem (X)	0.815	++0.80 - +0.84	Reliable
2	Innovation (Y)	0.885	+0.85 - +0.88	Very reliable

Table 4 shows that all research variables have reliable reliability values. The results of this reliability test indicate that all instruments used to measure the items of the entrepreneurial and innovation ecosystem variables, as operationalized in the operationalization of the variables, have acceptable reliability or consistency. Next, based on reliable and valid data, the significance of the path coefficient values of the research variables was calculated. The results of the calculations explained that the standardized coefficient values or path coefficients of each dimension were significant with a confidence level of 5% = 0.05, with the following explanation:

1) The first coefficient = 0.257, meaning that the material attribute dimension (X1) has a significant effect (0.000 < 0.05) on innovation.
2) The second coefficient = 0.232, meaning that the social attribute dimension (X2) has a significant effect (0.000 < 0.05) on innovation.
3) The third coefficient = 0.382, meaning that the cultural attribute dimension (X3) has a significant effect (0.000 < 0.05) on innovation.

Next, calculate the magnitude of the influence of each variable and sub-variable on the dependent variable, in this case, the Innovation variable, using path analysis. For the first sub-structure, namely the structure of the influence of variable X (Entrepreneurial Ecosystem) on Y (Innovation), path analysis is used with the results in Table 5 as follows:

Table 5.
Model summary of entrepreneurial ecosystem predictors.

Model summary

Model	R	R square	Adjusted R square	Std. error of the estimate
1	0.733a	0.537	0.523	3.96780

Note: a. Predictors: (Constant), entrepreneurial ecosystem.

Table 5 shows the coefficient of determination (R^2) value of 0.537, meaning that 53.7% of innovation variability can be explained by the independent variable, in this case, the entrepreneurial ecosystem. This can also be interpreted as indicating that there is an influence of the entrepreneurial ecosystem on innovation equal to the coefficient of determination (R^2 = 53.7%). Additionally, 53.7% can be interpreted as meaning that the influence of variables outside the model is $y = 1 - R^2$ = 0.463 (error). The magnitude of the path coefficient Table 6 for each variable is as follows:

Table 6.
Standardized coefficient values for path coefficients.

Model		Unstandardized coefficients		Standardized coefficients	T	Sig.
		B	Std. error	Beta		
1	(Constant)	5.290	1.080		4.897	0.000
	Ecosystem entrepreneur	0.649	0.032	0.733	20.529	00.0

Note: a. Dependent variable: Innovation.

The table explains the value of standardized coefficients or path coefficients from the entrepreneurial ecosystem variable to the innovation variable, namely the path coefficient from X to Y = 0.733. The results of these calculations can be seen in the following figure.

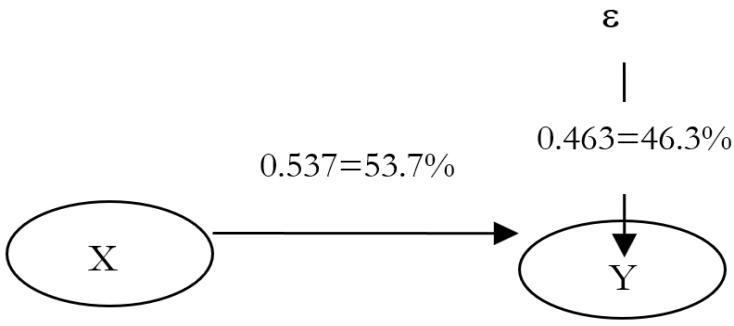

Figure 1.
The magnitude of the influence of Variable X on Variable Y.

Next, the second structural model will be tested to determine the extent to which material, social, and cultural attributes influence students' innovation (Y). The analysis method applied in this study is path analysis. The results of the path analysis are presented in the following table.

Table 7.
Model summary of innovation predictors.

Model summary

Model	R	R square	Adjusted R square	Std. error of the estimate
1	0.733[a]	0.537	0.534	3.92505

Note: a. Predictors: (Constant), culture attribute, material attribute, social attribute.

Table 7 shows that the coefficient of determination (R^2) is 0.537, indicating that 53.7% of the variation in the innovation variable can be explained by the independent variables—material attributes (X1), social attributes (X2), and cultural attributes (X3). This implies a collective influence of these three dimensions on innovation, with a determination coefficient of R^2 = 53.7%. Meanwhile, the remaining 46.3% (1 – R^2 = 0.463) represents the influence of other factors not included in the model. The path coefficient values for each dependent variable are detailed in Table 8.

Table 8.
Standardized coefficient values.

Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	Std. error	Beta		
1	(Constant)	4.605	1.092		4.215	0.000
	Material attribute, social attribute, cultural attribute.	0.475	0.089	0.257	5.336	0.000
		0.612	0.130	0.232	4.702	0.000
		0.957	0.106	0.382	9.024	0.000

Dependent Variable: Innovation

Based on the path coefficient values, it can be calculated that the influence of X1 on Y is 0.130, and the influence of X2 on Y is 0.159, as shown in the following picture.

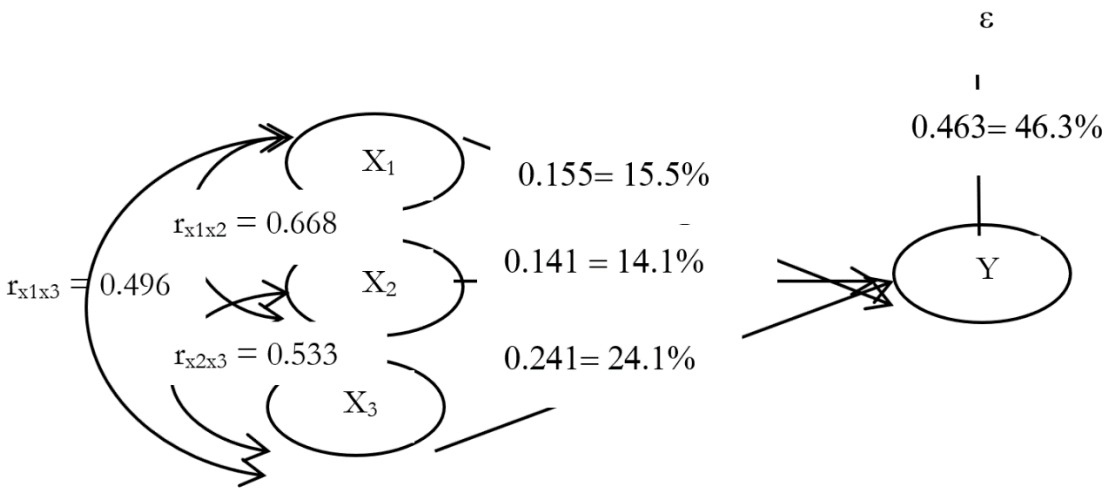

Figure 2.
The magnitude of the influence of dimensions X1, X2, and X3 on Y.

A clearer calculation of the total influence of each variable is visible in the table that follows.

Table 9.
Recapitulation of the Influence of X1, X2, and X3 on Y.

No.	Path	Direct influence and indirect (%)	Cumulative
1	ρYX1	15.5	15.5
2	ρYX2	14.1	29.6
3	ρYX3	24.1	53.7
	Others influence		46.3
	Influence total		100.00

The data above shows that the cultural attribute dimension has the greatest influence on innovation, followed by the material attribute dimension, which has a strong influence on the innovation variable. Meanwhile, the smallest influence on innovation is from the social attribute dimension.

4.2. Discussion

The findings of this research provide evidence that the Entrepreneurship Ecosystem has a positive and significant influence on innovation. These results support the conclusions of Gómez, who stated that entrepreneurial ecosystems are concentrations of urban economic activity where businesses start, innovate, grow, and create opportunities for other businesses [37]. Furthermore, this research highlights that the entrepreneurial ecosystem will encourage innovation results as stated below. Despite the growing body of research, the concept of the entrepreneurial ecosystem remains metaphorical and lacks a clear definition. There is still no consensus on the causal mechanisms that drive entrepreneurial ecosystems and lead to innovation outcomes, as current research presents diverse perspectives and remains fragmented. This study reviews 98 articles to synthesize existing evidence on entrepreneurial ecosystems, identifying the key aspects that enhance innovative capacity. The content analysis highlights three dominant themes: (1) the role of universities, (2) the role of entrepreneurial actors, and (3) innovation as a product of the entrepreneurial ecosystem. The findings emphasize the importance of interactions among ecosystem elements and underscore the critical role of entrepreneurial actors in driving innovation (18).

A statement that emphasizes that innovation can lead to a healthy ecosystem. These propositions outline a research agenda that examines the relationship between innovation and sectoral and temporal dimensions, the impact of innovation on firms and funders, the role of reinvestment into the ecosystem as the lifeblood for a self-reproducing healthy ecosystem, and the possible geographic limitations of ecosystem models [33].

The research findings indicate that material, social, and cultural attributes significantly impact innovation. As referenced in Alvi and Ulrich [32], these attributes form an interconnected Entrepreneurial Ecosystem. Material attributes encompass policies, universities, infrastructure, open markets, and support services. Social attributes include networks, mentors, role models, workforce talent, and investment capital, while cultural attributes involve a supportive culture and a history of entrepreneurship. Additionally, an Entrepreneurial Ecosystem requires seven types of capital: intellectual (ideas, knowledge), human (talent, skills, diversity), financial (funding, revenue), network (relationships, connectivity), cultural (attitudes, historical context, attachment to place), physical (infrastructure, environment), and institutional (laws, markets, stability). Although the focus is often on key actors and their roles, considering these factors is crucial, as they have spatial implications, such as zoning regulations and public transit accessibility [32]. The research further confirms that material attributes have a significant and positive impact on innovation. A key component of material attributes is institutional support, which includes facilities such as accelerators, incubators, hack labs, maker spaces, Fab Labs, launch labs, and technology transfer offices. This finding aligns with the statement in Huang, et al. [27], which emphasizes that the elements of an entrepreneurial ecosystem are strongly interconnected, reinforcing the systemic nature of entrepreneurial economies and the necessity of a complex systems perspective. The analysis highlights that physical infrastructure, financial resources, formal institutions, and talent play a central role in this interdependent network, identifying them as essential foundations of the entrepreneurial ecosystem. To catalyze innovation, academic institutions across the globe are actively engaging in various measures [37]. The current trend for innovation ecosystems is to use key mechanisms such as accelerators, incubators, hack labs, maker spaces, fab labs, launch labs, and technology transfer offices. Innovation mechanisms in university ecosystems are very important, especially in enhancing innovation Huang, et al. [27]. This is consistent with Sanjay's assertion that social and cultural dynamics shape the entrepreneurial ecosystem, where innovation emerges through interactions within this system. Entrepreneurial ecosystem research highlights the critical connection between organizational and contextual factors, facilitating entrepreneurs' creation and application of new knowledge (18). Recent studies on entrepreneurship and innovation have increasingly adopted a community-based perspective, emphasizing the role of social and cultural forces in shaping the ecosystem (28). Both academics and practitioners acknowledge the importance of entrepreneurial ecosystems in driving innovation (18). Furthermore, our review suggests that the success of an entrepreneurial ecosystem is determined by the commercialization of knowledge and its transformation into innovation (13). The capacity for innovation is crucial, as new ideas and innovative solutions serve as fundamental drivers of entrepreneurial opportunities and regional business development (18).

5. Conclusion

This study highlights the critical role of entrepreneurial ecosystems within universities in fostering student innovation. Strengthening institutional, social, and cultural attributes can significantly enhance entrepreneurial activities, benefiting students, educators, and policymakers alike. Despite its valuable contributions, the study's generalizability is limited due to its single-university scope, reliance on self-reported data, and the exclusive use of quantitative analysis. To build upon these findings, future research should explore diverse university settings, incorporate qualitative approaches, and examine additional influencing factors such as digital transformation and government policies. Longitudinal studies are also recommended to capture the evolving nature of entrepreneurial ecosystems and their long-term impact on student innovation and success.

5.1. Implications

The findings of this study underscore the importance of strengthening entrepreneurial ecosystems within universities to foster innovation among students. Practical steps include:

a. Enhancing institutional attributes such as university policies, infrastructure, and support services (e.g., business incubators and mentorship programs).
b. Encouraging social attributes, such as expanding professional networks, providing accessible mentors, and facilitating investment opportunities.
c. Promoting cultural attributes, such as fostering an entrepreneurial mindset, emphasizing personal achievement, and creating a supportive academic environment.

These implications are particularly relevant for policymakers, university administrators, and educators aiming to prepare students for entrepreneurial careers and enhance innovation within academic settings.

5.2. Limitations

While the study provides valuable insights, it has several limitations:

a. The research was conducted at a single university, Pasundan University, which may limit the generalizability of the findings to other higher education institutions.
b. The study relied on self-reported data, which may introduce bias due to subjective perceptions or social desirability.
c. The analysis was quantitative, which limits the depth of understanding regarding the nuanced interactions within the entrepreneurial ecosystem.

5.3. Future Research Suggestions

To address these limitations and expand on the findings, future research should:

a. Replicate this study across multiple universities and regions to enhance generalizability and explore contextual variations in entrepreneurial ecosystems.
b. Integrate qualitative methods, such as interviews or case studies, to provide a richer understanding of the mechanisms linking ecosystem dimensions to innovation.
c. Examine additional variables, such as the impact of digital transformation or the role of government policies, in shaping entrepreneurial ecosystems and innovation outcomes.

Conduct longitudinal studies to assess how entrepreneurial ecosystems evolve and their long-term effects on student innovation and entrepreneurial success.

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