The Development of the Entrepreneurship Ecosystem and Digital Technology in Vocational Education

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Abstract

This study examines the development of the entrepreneurship ecosystem and the integration of digital technology in vocational education, with a specific focus on public vocational schools in West Java Province, Indonesia. The analysis is based on two main frameworks: the entrepreneurship ecosystem, comprising actor-related and factor-related elements, and the digital technology ecosystem, which encompasses aspects of hardware, software, and brainwaves. The research employs a cross-sectional survey method within a quantitative descriptive evaluation design. The sample comprises vocational school teachers and students selected using Slovin's formula to ensure proportional representation. Data were collected using a validated and reliable structured questionnaire. The results were analyzed using frequency distribution and the Respondent Achievement Level (RAL) approach. The findings reveal significant variability across schools and indicators. Several digital technology indicators, such as the availability of free internet and the completeness of extracurricular entrepreneurship facilities, scored below 50%, indicating major areas for improvement. In contrast, indicators reflecting an entrepreneurial mindset and behavior, such as resilience, talent, and leadership, scored above 80%, demonstrating strong internal readiness for entrepreneurship development. The study highlights the need for targeted interventions in underperforming schools and continuous enhancement in schools already excelling. Inter-school collaboration is recommended, where high-performing schools can serve as best practice models to uplift others. These findings contribute valuable insights for vocational education stakeholders and policymakers, particularly in formulating strategies to enhance entrepreneurship education and foster digital-technology-based entrepreneurial competencies among students. Ultimately, the research supports the development of more adaptive and innovative vocational education ecosystems.

1. Introduction

Prosser expressed that the goal of education is not individual needs fulfilment but to fulfil the needs of labor or professional labor in a country. In contrary, Dewey has a certain view that the goal of public education is to fulfil individual needs and to prepare to live their lives. Dewey refuses an educational system that makes the students become passive which is controlled by the market economy but vocational education that enables students to solve problems. The views of both philosophical figures become the foundation of current vocational education.

The relationship between vocational education and digital technology-based entrepreneurship education is increasingly intertwined, as both play a synergistic role in preparing a future-ready workforce. Vocational education equips learners with practical and technical competencies, while digital entrepreneurship education fosters innovation, adaptability, and business acumen essential in the digital economy. This integration aligns with the growing emphasis on entrepreneurial ecosystems within TVET (Technical and Vocational Education and Training), where digital tools enhance entrepreneurial learning through simulations, e-commerce platforms, and AI-driven business models. Digital entrepreneurship leverages digital infrastructures to create new forms of value, thus requiring educational systems to adjust accordingly (Nambisan, 2017). Recent studies have also shown that integrating digital entrepreneurship into vocational education enhances students' entrepreneurial intentions and digital competence (Yela Aránega et al., 2023; Zuo et al., 2025). Moreover, digitally supported entrepreneurial pedagogy has been proven effective in improving learners' innovation capabilities and employment resilience in dynamic job markets (Garrido-Moreno et al., 2024). Therefore, embedding digital entrepreneurship within vocational curricula is essential to nurture learners who are not only job-ready but also capable of creating new economic opportunities in the digital era. The implementation of the Indonesian government to improve the competence of vocational education graduates, in 2018, created the "Entrepreneurial School (SPW)" program, a collaboration between the Directorate of Vocational High School Development and the Southeast Asian Ministers of Education Organization (SEAMEO). The main goal of vocationalization is to improve the relevance of education and vocational guidance with the needs of the world of work's development (Business Sector) in realizing a competitive wealthy country and sustainable development-oriented (Ramadhan et al., 2025).

According to the latest data from Statistics Indonesia (Badan Pusat Statistik/BPS, 2025), Indonesia's labor force reached 153.05 million people in February 2025, with 145.77 million employed and 7.28 million categorized as openly unemployed. This resulted in an open unemployment rate of 4.76%, a slight decrease from 4.82% in February 2024, reflecting improved labor absorption despite a growing labor force. The largest employment gains were observed in wholesale and retail trade (0.98 million), agriculture, forestry, and fisheries (0.89 million), and manufacturing (0.72 million). Compared to June 2022, when unemployment reached 8.4 million, the 2025 figures suggest gradual recovery and improved labor market performance. Additionally, the average monthly wage increased to IDR 3.09 million, a 1.78% rise from the previous year, indicating enhanced worker welfare alongside job growth (BPS, 2025). One of the suspected factors which contributed to this unemployment rate is the dependence of workers on the formal sector. Open unemployment can be anticipated with the entrepreneurship sector; the entrepreneurial process in vocational education with the integration of digital technology is an innovative step that must be taken considering the increasingly strong flow of digitalization so that the entrepreneurial spirit and personality can be increased (Mustaffa et al., 2024).

As of 2024, Indonesia's entrepreneurship ratio remains at 3.47%, which is still below the commonly cited 4% threshold required for becoming a developed nation and significantly lower than neighboring countries such as Singapore (8.76%), Malaysia (4.74%), and Thailand (4.26%) (APEC, 2024). Additionally, Indonesia ranks 75th out of 137 countries in the Global Entrepreneurship Index, reflecting persistent structural challenges in its entrepreneurial ecosystem. To address this gap, policy innovation is urgently needed, particularly in vocational education, through the implementation of relevant learning models such as the Teaching Factory (TEFA), Project-Based Learning (PBL), and the integration of digital platforms and online marketplaces. These models are essential for improving teacher competencies and building a more integrated and sustainable creative economy.

Vocational education, entrepreneurship and digital technology in nowadays era is one of essential components in the development of a country. The decree of the Ministry of Education and Culture number 71/M/2021 about the Vocational High School Centre of Excellence, explains the program of Vocational High School Centre of Excellence that aims to produce graduates who will be absorbed in the world of work or become an entrepreneur through alignment of in-depth and comprehensive vocational education with the world of work and is expected to be the center of quality improvement and reference for another vocational high school. One of the efforts to push entrepreneurship growth in Indonesia is the increment of synergy among educational institutes, business sectors, and industry. The partnership must be built based on a collaborative entrepreneurship learning framework to conduct relevant entrepreneurship projects in a knowledge-intensive company (Antoninis et al., 2023). The partnership also must be based on an innovative learning method that combines entrepreneurship and creative economy (Saleh & Drouillon, 2025).

Result of the research shows that entrepreneurship in the educational area needs a new approach evaluation in pedagogy, that is to adapt to business environment change happening in a country (Ionescu-Feleagă et al., 2025; Purohit & Dutt, 2024). The factors that affect the intention to become an entrepreneur, the key of success in entrepreneur learning is in innovation and the teacher's creativity, specifically in the utilization of learning strategy (Branca et al., 2025). Educational strategy by using lecture method and experiential learning cannot reach the expected result to ensure that the graduates are able to run their own businesses and to create employment opportunities in Zimbabwe (Mahere, 2024).

The development of research regarding vocational education and entrepreneurship has been done by previous researchers. Several themes observed by the researchers are related to vocational education, such as

educational system, student/college student, teacher/lecturer, learning process, and business world (Amalia & von Korflesch, 2021). For example, a research conducted at the Polytechnic of Malaysia on the lecturers who teach entrepreneurship by examining analysis of qualitative data using Nvivo software produced an entrepreneurship implementation method in the learning-teaching process(Zainal et al., 2020). In the development of entrepreneurship skills for the student, it is found that there are four main strategies needed to increase the entrepreneurship skill for vocational students in Ghana (Handayati et al., 2020). The research finds a way to evaluate the educational system from the owner and small-medium enterprisers' point of view in Czech and Slovakia, the result emphasizes the importance of a systematic approach in solving entrepreneurship education problem and the need to ensure the support of corporations in every level of education including lifelong learning (Gavurova et al., 2021).

Besides that, the culture in every place or country also affects the level of entrepreneurship development. In this case, Indonesia is a country that has very diverse cultures. Education of entrepreneurs in the context of transnational vocational education was done by two partners from Australia and Singapore. There were complexities of management such as the involvement among college students from different locations and cross-cultural bias in organizing the program, people, and learning (Pimpa, 2019). Research in India that discusses the impact of entrepreneurship towards the option of fresh graduates' life work reveals that Indian government policy, unskilled workers, education of entrepreneurship, family background, and caste are factors that affect the level of fresh graduates' growth to have a career in entrepreneurship (Naik et al., 2023). In African countries, the interest of graduates in running a business is still low. For example, the majority of agricultural vocational graduates in Nigeria tend not to build businesses but most of them want to get certificates of expertise to obtain paid work (M. Francis et al., 2019).

Related to the research about social media utilization in entrepreneurship, it is found that there are four factors affecting online entrepreneurs, they are trust, profit, learning, and social. They conduct online trade on Line, Facebook, and WeChat (Wu & Song, 2019). Designing a masterclass in horticulture business cooperation among Australia, Netherlands, and New Zealand aims to develop international reputation industrial relations in agricultural education and business. This produces business plans made by the students that should be presented in front of industrial and academic examiners (Acuña et al., 2019). The development of entrepreneurship through the cooperation of industrial institutions aims to identify the skills needed to become an entrepreneur and to learn the scope of interaction of industrial institutions to cultivate entrepreneurship skills in the youths (Singh et al., 2018).

The development of digital technology that grows rapidly affects the development of the business sector and education. The impact of digital technology forces the business world and education to be able to adapt. The speed of development of digital technology can become problems or solutions, it depends on the readiness of the institution of education and business itself. The research which is conducted in the field of education and entrepreneurship that is already compatible with metadata information has been done many times. However, when linked with entrepreneurship for vocational purposes and digital technology, the obtained publication data are still limited. Also, the published articles specifically related to the theme of vocational education and entrepreneurship, the discussion is still partial. Therefore, more comprehensive and in-depth research about vocational education and entrepreneurship is needed. For this reason, this research would analyse the development of entrepreneurship and digital technology in vocational high schools from some points of view.They are entrepreneurship ecosystem, and digital technology ecosystem.

This study will examine the development of the integration of vocational education and entrepreneurship with the development of digital technology in vocational education. The hope of this study will obtain findings on the implementation and development of vocational high schools into Entrepreneurial Schools (SPW) based on digital technology. The importance of digital technology in many sectors of life is increasingly felt; Indonesia's readiness to adopt and explore digital technology that can drive transformation in government, educational institutions, business models and people's lifestyles is also lacking. This is shown by the 2023 World Digital Competitiveness Ranking data, where Indonesia is ranked 45th out of 63 countries. How to adapt, education and training, technology ecosystems and integration of information technology, are issues that need to be addressed so that Indonesia can take advantage of advances in digital technology for economic growth and improving the quality of life.

1.1 Literature Review

Vocational education and entrepreneurship education are two unseparated things and each graduate not only depends on the availability of job opportunities, but also on the capability to create more job opportunities (Alsos et al., 2023). The development of the business world in this age is experiencing a lot of changes with the emergence of digital technology. Various terms regarding entrepreneurship and digital technology pop up, such as; e-commerce, mobile commerce, Artificial Intelligence, Internet of Things (IoT), and so on (Volkova et al., 2021). The result of research shows that digital technology has brought myriad advantages for organizations in some vital

parts like centralization, access to the new market, transpiration, and long-distance relationships related to the use of digital technology in business operations. To connect entrepreneurship skills and digital technology, the role of education is highly needed to increase human resource skills (Bai, 2021).

Education plays a vital role in knowledge-sharing and innovation which will continue to the digital entrepreneurship. This study will open a new lane in the field of education to incorporate hidden knowledge and transformational entrepreneurship (Zhao, 2021). Education and business sectors hold an important role in the development of patterns and learning systems to grow the students' skills in the field of entrepreneurship that is based on digital technology. The finding shows that a learning environment outside of the classroom has a strong connection with entrepreneurship education and entrepreneurship self-efficacy (Saptono et al., 2021). In the learning process of vocational high school, the students are equipped with vocational skills. The superiority of the skills can be a provision in integrating vocational skills and entrepreneurship which is linked to the development of digital technology.

The data comparison shows that the entrepreneurship characteristic of college students significantly and positively correlates with entrepreneurial attitude; the entrepreneurial self-efficacy of college students significantly and positively correlates with entrepreneurial attitude; and the entrepreneurship vigilance of college students significantly and positively correlates with entrepreneurial attitudes (Cao, 2021). A finding displays that the inclusion of vocational training and entrepreneurial skills in systems like shoe-making, tailoring, mechanical, poultry farming, phone repair, and weaving can contribute to national progress and sustainable economic development (Amuda, 2021a). This research demonstrates how and why the lack of research translation which supports emotional skills through education and training, as well as clinical practice, has been detrimental to entrepreneurs and future entrepreneurs (Aly et al., 2021). The development of entrepreneurial skills in the youths needs an articulation process-generating by different actors; family members, educational institutions, general society, government entities, and productive sectors (Campo-Ternera et al., 2022a).

This framework suggests that to develop an effective EE (Entrepreneurship Education) program in order to increase the OI (Opportunity Identification) individual performance, different perspectives about the emergence of opportunity and learning must be integrated into a consistent EE program and in line constructively (Farrokhnia et al., 2022).

2. Methodology

2.1 Participant

The participants consist of vocational school teachers and students. By using data from vocational high school teachers and students around West Java Province, Indonesia. The vocational high schools that have superiority criteria in every part of the area are located in Bandung City, Bandung Regency, West Bandung Regency, Tasikmalaya City, Ciamis Regency, and Sukabumi Regency. The chosen vocational high schools in this research are the schools that have advantages in the service area. The criteria used in identifying the strength point is seen from accreditation, internet speed, and certification of ISO 9001:2008.

Main education data from the Ministry of Education, Research, Technology and Culture of Indonesia shows that West Java Province has 288 (10%) state schools and 2634 (90%) private schools, this research uses state schools in West Java as the population. The number of data population consists of teachers and final-year students with details of 1.644 teachers and 77.784 final-year students.

To obtain participants, this study applied Slovin's formula to determine the minimum sample size required from a known population, ensuring representative sampling with manageable error tolerance. Slovin's formula is expressed as:

$$n = \frac{N}{1 + N(e)^2}$$

Where n is the sample size, N is the population size, and e is the margin of error. In this study, a confidence level of 95% (corresponding to a margin of error of 5%) was used. The population consisted of students and teachers from several vocational high schools in West Java. Based on the stratified sampling approach across selected schools, the calculation yielded a minimum of 5 teachers and 31 students per school to ensure sufficient representation. In total, 261 participants were recruited: 43 teachers and 218 students. Demographic data showed that 55.17% were female and 44.83% male. As for students' aspirations post-graduation, 52.72% aimed to enter the workforce, 19.67% planned to pursue higher education, and 27.62% aspired to become entrepreneurs. This distribution reflects the diversity of vocational school outcomes and highlights the relevance of integrating entrepreneurship education.

2.2 Instrument and Data Analysis

The instrument used in this research is questionnaire, with measuring scale used a five-point Likert scale (1 = Very Inappropriate, 5 = Very Appropriate). Those variables consist of two aspects of entrepreneurship ecosystem (element of actor and element of factor) and three aspects of digital technology (hardware, software, brainware). The stages of processing and analyzing data instrument tests are; an instrument validity test was conducted to determine whether the items were aligned with the underlying theoretical constructs. This process aimed to ensure that each question accurately represented the concepts being measured, based on the established theoretical framework. In general, an item is declared valid if it has an rxy value above 0.3, although there are also experts who say that an item validity value of 0.25 is said to be valid. The validation test criteria are if the price of t count > t table with a confidence level of 95% and degrees of freedom (n-2) then the question item is said to be valid. We conducted the validity test using Office Excel software and the SPSS program.24. The result of instrument validity is that from all indicators, there is only one invalid instrument in the four variable items of entrepreneurship ecosystem aspect of actors (business communities surrounding the schools contribute in the development of educational entrepreneurship). Second, the result of the reliability test on each construct has Cronbach's alpha value with > 0,06 on each. The result indicates that the collected data by using questionnaire instruments either variable X1 (entrepreneurship ecosystem), X2 (digital technology ecosystem), or variable Y (vocational high school) are reliable.

Third, this research uses the frequency distribution analysis RLA (Respondents' Level of Achievement) technique to analyze the collected data. Respondents' Level of Achievement is an evaluation method by arranging evaluated persons based on their level towards the varieties of evaluated characteristics. The research method shows a scale assessment, "Master Scale", it is a measurement scale that generally displays five levels of certain characteristics; very good, good, sufficient, insufficient, and not good.

Frequency distribution is a statistical method used to present data in the form of tables or graphs, with the aim of showing the distribution or spread of values in a group of data. Frequency distribution is used to find out how respondents' achievements are spread across various categories or certain intervals. This is important to know the patterns, tendencies, and characteristics of respondent data. Several stages determine the analysis of frequency distribution, such as; determining the range of data, calculating the minimum and maximum values of respondent achievement data, determining the number of classes or categories in the frequency distribution can be determined by the Sturges rule, determining categories or intervals, calculating relative frequencies, calculating cumulative frequencies, calculating averages, calculating standard deviations, and data interpretation and data visualization. The research result covers respondents' general description, validity test, reliability test, and frequency distribution analysis by using SPSS 24 which is then reprocessed to acquire the Respondents' Level of Achievement value percentage.

The writing of data analysis uses quantitative descriptive methods with data presentation techniques originating from statistics which then is conducted description observation systematically and accurately about facts between studied phenomena. This research uses RLA technique to analyze collected data. Respondents' Level of Achievement of an assessment method by arranging assessed persons according to the level in various assessed characteristics. This research method presents an assessment scale, "Master Scale", that is an assessment scale that generally shows five levels of certain characteristics. The description of master scale from the various characteristics can be seen in the Table 1.

Table 1 *Scale range of RLA*

No	Scale range	RLA
1	85%-100%	Very good
2	66%-84%	Good
3	51%-65%	Sufficient
4	36%-50%	Insufficient
5	0%-35%	Not good

3. Result and Discussion

3.1 Entrepreneurship Ecosystem in Elements of Actors and Factors

The result of realization at school according to the perspective of students and teachers by using the RLA value approach from every element aspect of the actor, the explanation of every indicator on the element aspect of the actor is described as follows. Both emerging and established business actors have maintained positive relationships with schools in the context of entrepreneurship education (X1.1.1). The Respondent Level of

Achievement (RLA) scores obtained were 75.26%, 73.33%, 82.20%, and 77.93%, all of which fall into the "good" category of achievement. Additionally, policy support, infrastructure, and assistance from both central and regional governments (X1.1.2) contributed to the development of school-based entrepreneurship programs, with RLA scores of 78.42%, 75.24%, 79.20%, and 76.21%—also categorized as "good". Policy/infrastructure and government support (central and regional) assist the development of educational entrepreneurship at the school (X1.1.2) with a score of 78,42% which indicates a good category, 75,24% which indicates a good category, 79,20% which indicates a good category, 76,21% which indicates a good category. Financial institution of bank/non-bank contribute in giving assistance/cooperation in educational entrepreneurship at the school (X1.1.3) with a score of 73,16% which indicates a good category, 65,24% which indicates a sufficient category, 70,80% which indicates a good category, 68,62% which indicates a good category. The available study program at the school is highly needed by the society that makes it worthy to become a marketable business model (X1.1.4) with a score of 84,74% which a indicates good category, 78,10% which indicates a good category, 82,20% which indicates a good category, 78,62% which indicates a good category. The public figure, surrounding societies and local communities (formal and informal) give support and contribution towards educational entrepreneurship at the school (X1.1.5) with a score of 74,74% which indicates a good category, 67,14% which indicates a good category, 74,00% which indicates a good category, 70,34% which indicates a sufficient category. To cultivate such an environment, a synergistic relationship between educational institutions, businesses, and industries is imperative. The proposed framework advocates for collaborative entrepreneurship learning to facilitate the execution of relevant entrepreneurial projects within knowledge-based enterprises (Garrido-Moreno et al., 2024; Rowan, 2025). The highest and the lowest RLA values of the Variables in the entrepreneurship ecosystem in elements of factors can be seen in Table 2.

Table 2 *The highest and the lowest RLA values of the variables in the entrepreneurship ecosystem in elements of factors*

	Name of vocational high school	SMKN X Bandung	SMKN X Tasikmalaya	SMKN X Ciamis	SMKN X Sukabumi
Element of Actors	The highest	X1.1.4	X1.1.4	X1.1.1	X1.1.4
		84,74	78,10	82,8	78,62
	The lowest	X1.1.3	X1.1.3	X1.1.3	X1.1.3
		73,16	65,24	70,8	68,62

There is an explanation of the RLA score of every indicator of factor element aspect, the explanation is described as follows. Much information (ideas, thoughts, advice) about entrepreneurship either inside or outside of the school environment (X1.2.1) gains a score of 89,47% which signifies very good category achievement, 86,67% which indicates very good category achievement, 89,20% which indicates very good category achievement, 81,03% which indicates a good category achievement. The knowledge and experience about entrepreneurship abundantly gained inside or outside of the school environment (X1.2.2) acquires a score of 90,00 % which signifies a very good category, 86,67 % which signifies a very good category, 88,00 % which signifies a very good category, 82,41 % which signifies a good category. Having received training, accompaniment, and consultation about entrepreneurship through programs at the school (X1.2.3) gains a score of 78,95% which means a good category, 78,57% which means a good category, 76,21% which means a good category, 76,21% which means a good category. To be an entrepreneur, talent, leadership, mindset, and resilience are needed in developing a business (X1.2.4) acquires a score of 91,05% which represents a very good category, 90,95% which represents a very good category, 79,20% which means a good category, 91,03% which represents a very good category. Culture, social interaction, the norm in the community environment, and local wisdom values in the school environment have represented entrepreneurship culture (X.1.2.5.) obtains a score of 78,42% which indicates a good category, 70,95% which indicates a good category, 79,20% which indicates a good category, 71,03% which indicates a good category. Ecosystem can be defined as a living community that correlates with different kinds of non-working components in an environment and interacts as a system. From another perspective, entrepreneurship ecosystem or business ecosystem is a group of corporations that connect and need each other to complete common goals in cooperation to create strategic partnerships that aims to give benefits for the consumers (Fuentes et al., 2024; Zhang et al., 2024). The highest and the lowest RLA values of the Variables in the entrepreneurship ecosystem in elements of factors can be seen in the Table 3.

Table 3 *The highest and the lowest RLA values of the variables in the entrepreneurship ecosystem in elements of factors*

	Name of vocational high school	SMKN X Bandung	SMKN X Tasikmalaya	SMKN X Ciamis	SMKN X Sukabumi
Element of Factors	The highest	X1.2.4	X1.2.4	X1.2.4	X1.2.4
		91,05	90,95	91,6	91,03
	The lowest	X1.2.5	X1.2.5	X1.2.5	X1.2.5
		78,42	70,95	79,2	71,03

Digital entrepreneurship is an innovative step in fostering entrepreneurial spirit and entrepreneurial character in education (Lupoae et al., 2024; Miah et al., 2025; Weng et al., 2025). The process of entrepreneurship in vocational education with the integration of digital technology is an innovative step that must be taken considering the increasingly strong flow of digitalization so that the spirit and personality of entrepreneurship can be improved (Elia et al., 2024; Plekhanov et al., 2023). The main distinction between this study and previous research lies in the scope and analytical dimensions applied. Prior studies in the fields of education and entrepreneurship have often been limited to specific themes, such as evaluating the effectiveness of pedagogical approaches or analyzing co-authorship patterns within certain regions or timeframes (Kraus et al., 2020; Rocha et al., 2024). For instance, a study conducted by Ahmad et al. focused solely on entrepreneurship education in higher education institutions through a bibliometric analysis, while another by Zhang and Li examined citation patterns in business education journals without exploring topic trends or institutional networks in depth (Wan & Lv, 2021). In contrast, this study offers a broader and more integrative perspective by analyzing several key dimensions: (1) publication growth trends over the past decade; (2) institutional and author contributions in advancing research in education and entrepreneurship; and (3) identification of emerging research themes through keyword co-occurrence mapping and thematic evolution analysis. Through this comprehensive approach, the study contributes to a deeper understanding of the global knowledge landscape and highlights both prominent research hotspots and underexplored areas at the intersection of education and entrepreneurship.

Innovation is a trend found in this study, meaning that entrepreneurship education needs to carry out continuous innovations to meet the development of the times. Currently, digital technology has emerged as an unavoidable need (Patrício & Ferreira, 2023). The rapid and rapid development of digital technology greatly influences the development of the business and education worlds. The influence of digital technology makes the business and education worlds must be able to adapt. The speed of digital technology development can be a solution or a problem depending on the readiness of educational and business institutions (Javaid et al., 2024; Tagscherer & Carbon, 2023). With the rapid digitalization of products and services across industries, entrepreneurial opportunities in this market (products and services) are also increasingly open with digital technology (Dabbous et al., 2023; Vărzaru & Bocean, 2024). The average RLA value for each aspect of the entrepreneurship ecosystem can be seen in the Figure 1.
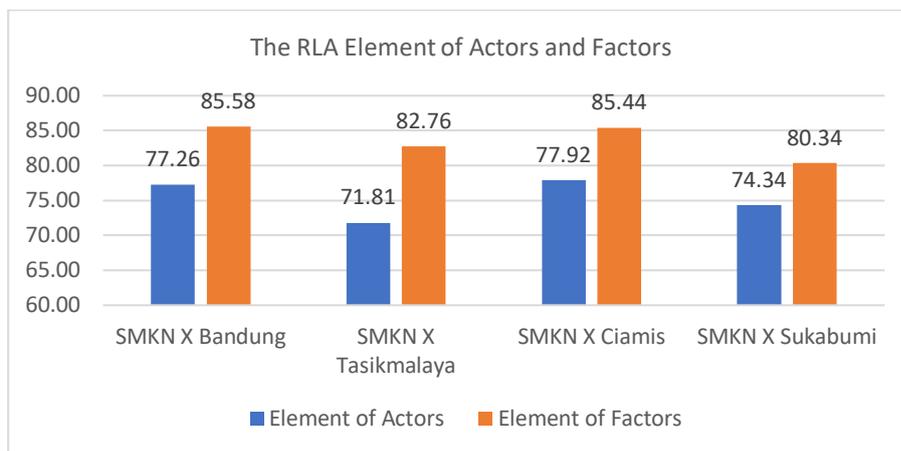

Fig. 1 *The average RLA value for each aspect of the entrepreneurship ecosystem*

3.2 Digital Technology Ecosystem in Aspects of Hardware, Software, and Brainware

The explanation of RLA score from each indicator of hardware aspects is described as follows. The school has a Computer Laboratory/computer hardware that fulfills the needs of students, teachers, and educational staff (X2.1.1) obtains a score of 86,84% which displays very good category achievement, 85,71% which displays very good category achievement, 89,60% which displays a very good category achievement, 77,59% which displays a good category achievement. The computer hardware at schools can be used optimally in accordance with the development of current technology (X2.1.2) gains a score of 85,26% which means a very good category, 80,48% which means a good category, 82,40% which means a good category, 66,21% which means a good category. The school has an infrastructure of internet connection that can be accessed freely by the school residents (X2.1.3) obtains a score of 63,16% which indicates sufficient, 78,57% which indicates a good category, 78,00% which indicates a good category, 61,72% which indicates a sufficient category. The school has classrooms that are equipped with the latest digital technology (X2.1.4) acquires a score of 71,58% which means a good category, 68,10% which represents a good category, 64,40% which represents a sufficient category, 56,90% which represents a sufficient category. The hardware/equipment owned by the school is integrated with the information system so that enables the students and teachers to complete the school tasks (X2.1.5) obtains a score of 72,63% which indicates a good category, 70,95% which indicates a good category, 77,20% which indicates a good category, 64,83% which indicates a good category. The highest and the lowest RLA values of the Variables in the entrepreneurship ecosystem in elements of factors can be seen in the Table 4.

Table 4 *The highest and the lowest RLA values of the variables in the entrepreneurship ecosystem in elements of factors*

	Name of vocational high school	SMKN X Bandung	SMKN X Tasikmalaya	SMKN X Ciamis	SMKN X Sukabumi
Hardware	The highest	X2.1.1	X2.1.1	X2.1.1	X2.1.1
		86,84	85,71	89,6	84,00
	The lowest	X2.1.3	X2.1.4	X2.1.4	X2.1.3
		63,16	68,10	64,4	44,50

The RLA score explanation of every indicator of software aspect is described as follows. The computers at school have an operation system (such as: Windows, Linux, Android) that is updated with the current needs (X2.2.1) gains an RLA score of 79,47% which presents a good category achievement, 78,10% which shows a good category achievement, 85,60% which shows a very good category achievement, 72,76% which shows a good category achievement. The school facilities have software applications that are equipped with *suite office* covers Microsoft Word, Excel, and etc. to conduct the data processing, presentation, and other activities (X2.2.2) obtains a score of 80,53% which displays a good category, 85,24% which indicates a good category, 93,60% which indicates a very good category, 76,82% which indicates a good category. The school facilities have the software application for graphic and design necessities covers Adobe Photoshop, Corel Draw, and so on, to produce graphic, illustration, and design (X2.2.3) acquires a score of 73,68% which means a good category, 73,33% which means a good category, 82,20% which means a good category, 69,66% which means a good category. The school facilities have software application of web and programming for the search projects on websites and application development (X2.2.4) gains a score of 71,58% which presents a good category, 76,19% which indicates a good category, 80,80% which indicates a good category, 66,55% which indicates a sufficient category. The school facilities have software applications equipped with multimedia applications, such as audio player, audio or video editor, to access and organize media, (X2.2.5) gains a score of 73,68% which means a good category, 73,81% which means a good category, 77,20% which means a good category, 65,86% which means a sufficient category. The school facilities have software applications that are equipped with creative applications such as animation software, music, and business, to facilitate the students' talent and interest (X2.2.6) obtains a score 70,53% which shows a good category, 71,43% which shows a good category, 75,20% which shows a good category, 64,83% which shows a sufficient category. The highest and the lowest RLA values of the Variables in the entrepreneurship ecosystem in elements of Software can be seen in the Table 5.

Table 5 *The highest and the lowest RLA values of the variables in the entrepreneurship ecosystem in elements of software*

	Name of vocational high school	SMKN X Bandung	SMKN X Tasikmalaya	SMKN X Ciamis	SMKN X Sukabumi
Software	The highest	X2.2.2	X2.2.2	X2.2.2	X2.2.2
		80,53	85,24	93,6	78,62
	The lowest	X2.2.6	X2.2.6	X2.2.6	X2.2.6
		70,53	71,43	75,2	64,83

The RLA score explanation of every indicator of brainware aspect is described as follows. The school has technology of information experts and developers with deep understanding about digital technology and latest trends (X2.3.1) gains an RLA score of 75,26% which shows a good category achievement, 77,14% which indicates a good category achievement, 83,60% which indicates a good category achievement, 66,21% which indicates a good category achievement. The users are given special training to utilize the applications that are built at the school (X2.3.2) obtains a score of 69,47% which indicates a good category, 72,86% which displays a good category, 80,00% which displays a good category, 68,97% which displays a good category. The school has Standard Operating Procedure (SOP) in using the owned applications or digital contents (X2.3.3) acquires score of 74,74% which displays a good category, 75.71% which indicates a good category, 84,40% which indicates a good category, 75,17% which indicates a good category. The school has digital content in learning teaching activity (X2.3.4) scores 76,32% which presents a good category, 75,86% which shows a good category, 75,86% which shows a good category, 75,86% which shows a good category. The digital technology users at the school are able to operate the digital facilities that currently exist (X2.3.5), gains a score of 72,63% which represents a good category, 73,81% which shows a good category, 78,40% which indicates a good category, 74,48% which indicates a good category. The results of the average percentage approach to the RLA value for each aspect of the entrepreneurship ecosystem and digital technology ecosystem variables at SMKN X Bandung City, SMKN X Tasikmalaya, SMKN X Ciamis, SMKN X Sukabumi are explained in figure 2. Digital ecosystem or online ecosystem constitutes the development of information of technology that is related to each other among software, hardware, and brainware, and as a function in creating unity. Thus, the system can involve many parties such as suppliers, customers, trading partners, third party data provider, and etc. Business to business practice integration, business application, and source of data into an ecosystem which enables an organization to control the technology (Kraus et al., 2022; Toorajipour et al., 2024). The highest and the lowest RLA values of the Variables in the entrepreneurship ecosystem in elements of Brainware can be seen in the Table 6.

Table 6 *The highest and the lowest RLA values of the variables in the entrepreneurship ecosystem in elements of Brainware*

	Name of vocational high school	SMKN X Bandung	SMKN X Tasikmalaya	SMKN X Ciamis	SMKN X Sukabumi
Brainware	The highest	X2.3.4	X2.3.1	X2.3.3	X2.3.4
		76,32	77,14	84,8	75,86
	The lowest	X2.3.2	X2.3.2	X2.3.5	X2.3.1
		69,47	72,86	78,4	66,21

The integration of entrepreneurship education and vocational education is very important because in addition to vocational education graduates having competence, graduates are also required to have good entrepreneurial attitudes and competencies. Vocational education students who are mentally able to work in the field but are not accompanied by entrepreneurial experience will be a problem in the future (Poláková et al., 2023). Vocational graduates who have entrepreneurial provisions must be able to compete in the job market and survive. Entrepreneurship education with a production-based learning approach provides opportunities for students to be able to apply the results of project work in the form of quality and highly marketable business plans. In addition, independence and entrepreneurial attitudes will also grow and emerge along with the integration of entrepreneurship learning in vocational education. The soul and spirit of entrepreneurship need to be transmitted and improved in students, this will have an impact on the vocational education environment to be better. Production-based learning is very appropriate as a basis for developing entrepreneurship pedagogy in vocational education, and policies and rules are needed to realize the competence of quality vocational education graduate (Morselli & Marcelli, 2022). The average RLA value for each aspect of the digital technology ecosystem variables
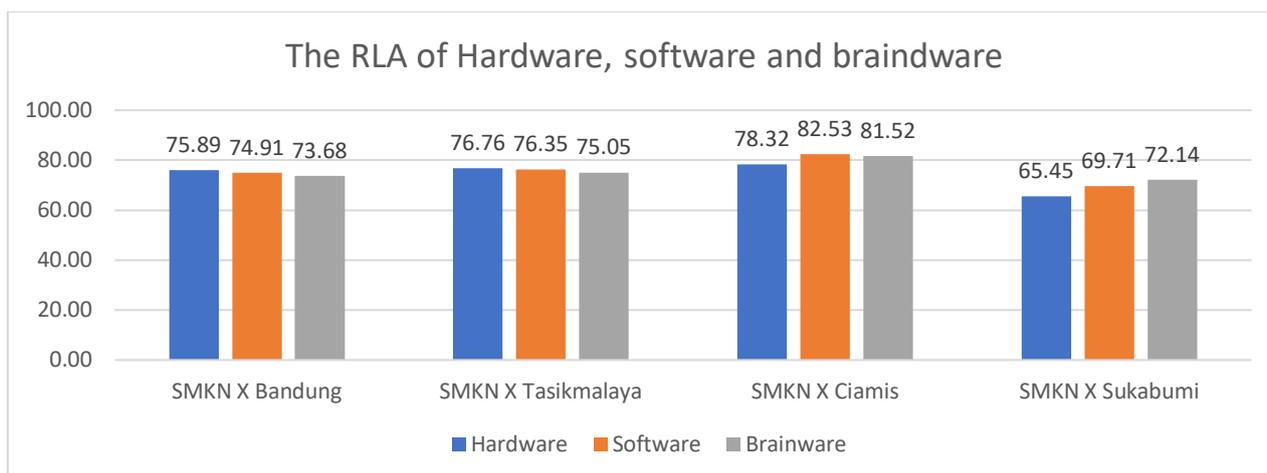
can be seen in the Figure 2.

The RLA of Hardware, software and braindware

- Hardware values: SMKN X Bandung 75.89, SMKN X Tasikmalaya 76.76, SMKN X Ciamis 78.32, SMKN X Sukabumi 65.45
- Software values: SMKN X Bandung 74.91, SMKN X Tasikmalaya 76.35, SMKN X Ciamis 82.53, SMKN X Sukabumi 69.71
- Brainware values: SMKN X Bandung 73.68, SMKN X Tasikmalaya 75.05, SMKN X Ciamis 81.52, SMKN X Sukabumi 72.14

Fig. 2 *The average RLA value for each aspect of the digital technology ecosystem variables*

The result of respondents' level of achievement analysis on every variable of entrepreneurship ecosystem and digital technology ecosystem in vocational high schools in West Java Province. These are the findings in every indicator from the highest category to the lowest of its alignment. Entrepreneurship ecosystem variable actor element aspects is indicated obtaining the highest value on the indicator of "the available study program at the school is highly needed by the society that makes it worthy to become a marketable business model. While the lowest value is acquired by the indicator of "the public figure, surrounding societies and local communities (formal and informal) give support and contribution towards educational entrepreneurship at the school". The result of the public perception represents that there is an easier digital business deal to be built and more sustainable than the traditional business (Martínez-Peláez et al., 2023; Verhoef et al., 2021). The environment around the school has an impact in the development of entrepreneurship education, it is in line with the finding which shows that the learning environment outside of the classroom has a close relationship with the entrepreneurship education and entrepreneurship self-efficacy (Meyer et al., 2023).

Subsequently, aspect of element factor which gains the highest value is the indicator of "to be an entrepreneur, talent, leadership, mindset, and resilience are highly needed in developing a business", while the lowest value is obtained by the indicator of "having received training, accompaniment, and consultation about entrepreneurship through programs at the school". The finding indicates that the accompaniment plays a vital role in the sharing of knowledge and innovation which then leads to digital entrepreneurship (Lopes et al., 2025; Satalkina & Steiner, 2020).

The next is variable of digital technology ecosystem, the hardware aspect which acquires the highest value is the indicator of "the school has a Computer Laboratory/computer hardware that fulfills the needs of students, teachers, and educational staff", while the lowest value is gained by the indicator of "the school has an infrastructure of internet connection that can be accessed freely by the school residents". The finding signifies that technology has brought benefits for organization, such as centralization, access to the new market, and long-distance managerial in business operations that give essential advantages for the business world (Ahi et al., 2022; Massa et al., 2023).

The aspect of software indicator which gains the highest value is "the school facilities have software applications that are equipped with *suite office* covers Microsoft Word, Excel, and etc. to conduct the data processing, presentation, and other activities", while the lowest value is acquired by the indicator of "the school facilities have software applications that are equipped with creative applications such as animation software, music, and business, to facilitate the students' talent and interest". The last is brainware aspect, the indicator which obtains highest value is "the school has Standard Operating Procedure (SOP) in using the owned applications or digital contents", while the lowest value is gained by the indicator of "the users are given special training to utilize the applications that are built at the school". The value of each entrepreneurship ecosystem variable and digital technology ecosystem variable can be seen in Figure 3.

The school condition regarding the strength and the weakness in fulfilling its ecosystem of entrepreneurship and its ecosystem of digital technology becomes a focus that must be noticed by vocational high schools. The attention and support constitute the power to idealize vocational high school graduates who have skills and spirit to be an entrepreneur so they can contribute to the development of the human resources of their country. The

research findings prove that the inclusion of vocational training and entrepreneurship skills such as shoe making, sewing, mechanical, poultry farming, phone reparation, and weaving, can contribute to national progress and sustainable economic development in North Nigeria (Amuda, 2021b). Entrepreneurship education and entrepreneurship policy have similar goals to spur the entrepreneurship activity and its impact towards individuals, organizations, regions, and countries. The research result shows that the lack of translation research that support emotional skill through education and training, as well as in clinical practice, has harmed entrepreneurs, future entrepreneurs, region, province, and country, that see entrepreneurship as a means to spur economic development and living standard as a whole (Wang et al., 2024). The highest and the lowest RLA total value at vocational high schools in West Java Province can be seen in the Figure 3.
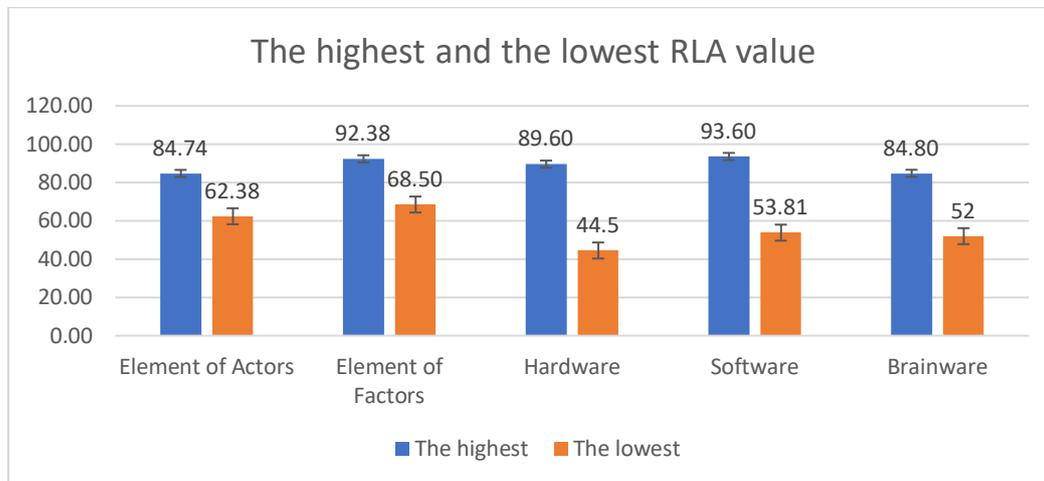
Fig. 3 *The highest and the lowest RLA total value at vocational high schools in West Java Province*

The findings from the result and discussion show that the variable indicators of entrepreneurship ecosystem and technology digital ecosystem at every vocational high school in West Java Province, Indonesia, vary greatly in value. It indicates that improvement is still needed for the schools that obtain low value and development for the schools that obtain good value. The cooperation among schools can be one of alternative solutions to improve the weaknesses existing at schools. The schools that acquire the highest aspect/indicator value can be *best practice* for the schools that still have low value.

The value that is in the spotlight in the entrepreneurship ecosystem is in the aspect of the actor element which has the lowest value, "the public figure, surrounding societies and local communities (formal and informal) give support and contribution towards educational entrepreneurship at the school". The information proves that the vocational high school needs to pay more attention to the surrounding environment to support each other in the field or entrepreneurship. Entrepreneurship development, which is based on strengthening the potential of the surrounding environment, needs cooperation among stakeholders. Likewise, the student entrepreneurship behavior is influenced by the surrounding environment so that the environmental factors that can motivate and strengthen the student entrepreneurial spirit must be strengthened by the vocational school. The findings of the previous research show that the college student entrepreneurship behavior significantly correlates positively with the entrepreneurship attitude, the college student entrepreneurship self-efficacy correlates positively and significantly with the entrepreneurship attitude (Fan et al., 2024). The development of entrepreneurship skills to the youths needs an articulation process among different factors: family members, educational institutions, society in general, government entities, and productive sector (Campo-Ternera et al., 2022b).

The next is in the digital technology ecosystem variable on each aspect still has very low condition. The indicator hardware aspect of "the school has an infrastructure of internet connection that can be accessed freely by the school residents". The indicator software aspect of "the school facilities have software applications that are equipped with creative applications such as animation software, music, and business, to facilitate the students' talent and interest". The indicator brainware aspect of "the users are given special training to utilize the applications that are built at the school". From this research result, it can be found that the digital technology ecosystem at the vocational high school in every aspect is still low. Therefore, the vocational high schools must improve the facilities of the digital technology ecosystem in all aspects, hardware, software, and brainware, specifically that relates to the entrepreneurship field so that the potentially increase to produce graduates who have digital entrepreneurship digital skills.

Here are some practical implications of the findings and recommendations for educators and policymakers: Digital innovation should be integrated into the curriculum. This will help students learn about technologies such

as e-commerce, data analytics, and innovative platforms that help them build digital-based businesses. It is recommended that educational institutions build practical entrepreneurial skills by providing entrepreneurship labs or collaborative workspaces where students can develop and test business ideas in a safe environment. To enhance innovation and creativity, it is recommended to provide additional training or incubator programs to help students develop their innovative ideas with the help of industry experts or mentors. The integrated model of entrepreneurship education, vocational education, and digital technology provides a holistic approach to developing practical and entrepreneurial skills that are relevant to current industry needs. Through the use of digital technology, students can develop innovative solutions that integrate technical, entrepreneurial, and digital aspects for various sectors, such as IT, energy, agriculture, and creative arts.

4. Conlusion

The findings indicate significant variation in the entrepreneurship ecosystem and digital technology ecosystem variables across vocational high schools in West Java Province. Schools with lower performance values require targeted improvement, while those with higher values should continue to build on their existing strengths. Collaboration among schools presents a strategic opportunity to bridge these gaps particularly through formalized partnerships where high-performing schools serve as models or training hubs. This underscores the need for policy frameworks that mandate or incentivize inter-school collaboration, knowledge sharing, and peer mentoring within the vocational education system. In the entrepreneurship ecosystem, the lowest-scoring element was the role of actors, specifically the limited involvement of public figures, local communities, and surrounding societies in supporting entrepreneurship education. This finding emphasizes the importance of policy-driven stakeholder engagement, encouraging schools to actively collaborate with families, local governments, higher education institutions, and industry actors. Strengthening these networks is essential for fostering a culture of entrepreneurial behavior among students. The digital technology ecosystem remains underdeveloped in many vocational schools, with consistently low performance across infrastructure (hardware), applications (software), and capacity (human resources). Persistent barriers include inadequate internet infrastructure, lack of relevant and engaging digital learning tools, and insufficient user training. To address this, policy initiatives should support investments in digital infrastructure, teacher digital capacity-building, and the integration of digital entrepreneurship competencies into the curriculum. Practical steps should include integrating digital innovation into teaching and learning by exposing students to tools such as e-commerce platforms, data analytics, and digital business simulations. Schools should be encouraged through supportive policy mandates to establish entrepreneurship labs, collaborative innovation hubs, or business incubators in partnership with industry. These environments would enable students to apply vocational skills in entrepreneurial contexts, experiment with digital tools, and receive mentorship from professionals. Ultimately, a holistic policy supported model that integrates entrepreneurship education, vocational training, and digital innovation is vital to ensure students are equipped with the interdisciplinary skills needed to compete and innovate in the digital economy.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper. This research was conducted independently without any financial or commercial relationships that could be construed as a potential

conflict of interest. All data were collected and analyzed objectively to ensure the integrity and credibility of the findings.

Author Contribution

*The authors confirm their contributions to the paper as follows: **study conception and design:** Sultono and M. Syaom Barliana; **data collection:** Sultono and Tutin Aryanti; **analysis and interpretation of results:** Sultono, M. Syaom Barliana, Tutin Aryanti, and Dedy Suryadi; **draft manuscript preparation:** Sultono and M. Syaom Barliana; **critical revision and finalization:** all authors. All authors reviewed the results and approved the final version of the manuscript.*

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