

## Model of Digital Collaboration Network in Digital Innovation Context: Social Network Analysis Approach

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### ABSTRACT

This research aimed to produce a network structure in a digital collaboration network to determine the position of each participating actor in supporting digital innovation among digital entrepreneurs in West Java, Indonesia. Mixed methods were used with an exploratory sequential strategy involved 110 digital entrepreneurs, and the data were obtained using questionnaires and interviews. This research used regression testing to test the relevance of digital collaboration network and digital innovation variables. This research also adopted a social network analysis (SNA) approach using the Gephi application to obtain the network structure in a digital collaboration network. The results confirmed that the digital collaboration network significantly affects digital innovation among digital entrepreneurs in West Java. Another result showed that Tita Hernawati (Dapur Tihwa Corporation) was the actor with the highest degree of centrality and eigencentality in the digital collaboration network of West Java. In this context, Tita Hernawati could be considered the actor who played the highest role in the digital collaboration network. Further research should be conducted to expand digital collaboration network by integrating the perspectives of all actors to develop a complete model.

Keywords: Digital Entrepreneur, Digital Collaboration Network, Digital Innovation, Social Network Analysis.

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## 1. INTRODUCTION

In the current era of digitalization, information technology causes disruptions on the social and industrial levels (Vial; 2019; Chen & Lai, 2022), and encouraging digital technology leads to significant changes in the field of entrepreneurship (Azzahra *et al.*,

2021). Due to technology adoption, entrepreneurship has changed, and new forms of the concept have been developed (Giones & Brem, 2017) as "digital entrepreneurship" (GÜĞERÇİN & Gaye, 2021). This concept broadly refers to creating new ventures and transforming existing businesses by developing and using new digital technologies (Biclesanu *et al.*, 2021; Sahut *et al.*, 2021). Digital entrepreneurs have been considered an essential pillar for economic growth and innovation as well as the top priorities of many countries (Leong *et al.*, 2016; Shen *et al.*, 2023). Therefore, skills and abilities in applying creative processes and innovations using digital technology to create new sources of value and wealth as critical components of digital entrepreneurship are necessary (Soltanifar *et al.*, 2023). In this context, digital innovation drives entrepreneurial activity (Kuester *et al.*, 2018; Elijah, 2023; Purbasari *et al.*, 2023).

Nambisan *et al.*, (2017) explained that the nature of innovation was subjected to significant changes in most industries due to digitalization. These changes are shown in the phenomenon where innovations are generated in collaborative processes and become more connected within a vast network of stakeholder actors. However, many entrepreneurs still face challenges in identifying potential opportunities due to limited knowledge, resources, and networks. These barriers must be overcome to drive digital innovation in companies (Khanin *et al.*, 2022; A. & Gavrilă, 2023). Many digital innovations require fundamentally different capabilities since entrepreneurs collaborate with partners who possess the capabilities (Bogers *et al.*, 2022; Smailhodžić & Denis Berberović, 2021; Tiwana, 2018).

Collaboration networks are considered functional in spreading innovative services to produce new products for the market (Soetanto & Marina Van Geenhuizen, 2015). According to Bunduchi *et al.*, (2022), "collaborating with other actors" is a valuable solution for digital entrepreneurs to acquire development and commercialization capabilities (Felicetti *et al.*, 2023). In this context, companies can improve their competitive position through increased access to innovation, knowledge, and unavailable complementary resources (Koch & Windsperger, 2017; Tiwana, 2018). Moreover, network relationships are transforming from cooperation to collaboration and shared value creation (Lusch *et al.*, 2016; Yaqub *et al.*, 2020).

Currently, research on digital entrepreneurship still has gaps, leading to different debates (Nambisan *et al.*, 2017; Kraus *et al.*, 2019) related to the topic of digital transformation (Kraus *et al.*, 2021), innovation (Ancillo & Gavrilă, 2023), and collaboration networks (Hund *et al.*, 2021). Even though digital technology has changed innovation (Bharadwaj *et al.*, 2013; Lyytinen *et al.*, 2016), there is a remarkable network of connections between actors and the concept (Sandberg *et al.*, 2020; Hund *et al.*, 2021; Wang, 2021). Additionally, research that discusses the ability of digital collaboration on innovation still needs to be completed. According to previous studies, digital collaboration capabilities lead to innovation through the process of exchanging and sharing knowledge, information, and experience among partners (Ravichandran, 2018; Nasiri *et al.*, 2020; L. Li *et al.*, 2022). However, no in-depth study of the model has been reported in the context of digital innovation, specifically with SNA tools. Despite implicit assumptions about the importance of stakeholders, the role of interaction in value creation has not been widely discussed in the entrepreneurship and digital innovation literature (Grönroos & Voima, 2012; Wang, 2021). Considering the social and networked nature, conventional research methods are still limited to finding the complexity and dynamic interaction between digital technology and entrepreneurship, a new methodological approach to explain the

phenomenon (Nambisan *et al.*, 2017; Beliaeva *et al.*, 2020). Therefore, there is a need for an integrative and holistic approach to obtain a comprehensive explanation of digital entrepreneurship, innovation, and collaboration networks. The gaps from previous studies were identified, specifically regarding the limited approach adopted in the network research and obtaining a correct analysis of collaboration activities. Social network analysis and strategic thinking approaches are suitable for exploring the relationships and interdependencies of ecosystem actors for value creation (Zahra & Nambisan, 2011; Kapoor & Lee, 2013).

This research was conducted on digital entrepreneurs in Indonesia, where the growth continues to show a positive trend, specifically in the province of West Java (Digital Creative Industry Society, 2019). The selection of digital entrepreneurs in West Java Province as the locus of research is based on the consideration as the center of excellence for the digital creative industry after DKI Jakarta (Rofaida *et al.*, 2019). According to the East Ventures - Digital Competitiveness Index (EV-DCI) 2021 report, West Java is the most superior province in the availability of digital human resources. BPS West Java Province stated that the information and communication sector increased up to 39.75% throughout 2020 to absorb a large workforce (Rizaty, 2021). Due to the digital talent strength, the province has the second highest competitiveness after Jakarta, with a score of 58.5 based on the Digital Competitiveness Index 2022 (EV-DCI 2022) (Rizaty, 2021; Media Indonesia, 2022).

This research aimed to produce a network structure in a digital collaboration network to determine the position of each participating actor in supporting digital innovation among digital entrepreneurs in West Java, Indonesia. This research uses a SNA approach to determine the model in the context of digital innovation. Some limitations are complemented regarding digital entrepreneurs, innovation, and collaboration networks from previous studies by providing answers to the questions related to the concept as an effort to improve talent and entrepreneurial quality.

## 2. LITERATURE REVIEW

### 2.1 Digital Collaboration Network

*Digital collaboration network* is a virtual ecosystem that allows business actors to collaborate and build coalitions in a virtual setting (Fachrunnisa, 2016). Meanwhile, virtual collaboration can be defined as long-term strategic interaction based on mutual agreement and sharing of resources to create mutual benefits (Hoyer & Oliver Christ, 2007). Albert *et al.* (2010) stated that *digital collaboration network* can be formed to serve the simple purpose of informing the community or the broader objective of rebuilding the economic foundation to create efficiency, new opportunities, and quality of life. Albert *et al.* (2010) reported that *Digital collaboration network* could be measured based on the objectives to be achieved, namely (Fachrunnisa *et al.*, 2013):

1. *Co-Inform*: Actions to identify members and impact, raise awareness of issues, and improve communication among members,
2. *Co-Learn*: Network-sponsored education and training programs,
3. *Co-market*: A collective activity that promotes a member's products or services within the state or abroad,
4. *Co-Purchase*: Activities to strengthen buyer-supplier relationships or jointly buy expensive equipment,

5. *Co-Produce*: Alliances to create products or conduct Research and Development (R&D),
6. *Co-Build*: The foundations of a common economy relating to building institutions, Education, finance, and stronger governance that allow society to compete better.

## 2.2 Digital Innovation

The original definition of innovation was a new combination of resources for the development of new products, introduction of new production methods, development of new markets, acquisition of new sources of resources, and organizational reform through creative activities (Schumpeter, 1926; Oshima & Toma, 2023). Digital innovation is the use of technology during the innovation process. In this context, the concept refers to the innovation of products, processes, or business models using digital platforms within and across organizations (Ciriello *et al.*, 2018). Another definition states that digital innovation is the creation, adoption, and exploitation of the novelty of inherently unlimited products, services, processes, or business models through the incorporation of technologies (Hund *et al.*, 2021). Digital innovation has radically changed the nature and structure of new products and services, realizing new value creation and enabling collective innovation involving a dynamic set of actors with diverse objectives and capabilities, to generate a new generation of innovation processes (Boudreau & Lakhani 2013; Iansiti & Lakhani 2014; Nambisan *et al.*, 2017; Ciriello *et al.*, 2018; Hund *et al.*, 2021)

## 2.4 Social Network Analysis (SNA) Approach

SNA refers to the mechanisms and processes of interaction within a network structure to obtain results specific to individuals and groups (Borgatti & Halgin, 2011; Neumeyer *et al.*, 2017). The relationships are interrelated to achieve similar objectives, forming a path indirectly connecting actors who are not directly bound. The pattern of bonding in the network produces a certain structure, and actors occupy positions in the structure. Most network theory analyses examine the characteristics of the structure and actor position (centrality) and the attempt to relate the concept to the achievements or outputs produced (Borgatti & Halgin, 2011). SNA can be used to describe relationships between organizations with common or complementary features that facilitate access to resources and information or to determine the structure of social interactions (Letaifa *et al.*, 2016; Purbasari *et al.*, 2018). Jack *et al.* (2009) considered SNA a key element of entrepreneurial research. Network approach and strategic thinking are suitable since the relational structure between different stakeholders is an aspect implicit in the approach, which explores the level of connectivity between actors affecting social network (Neumeyer & Santos, 2018; Purbasari *et al.*, 2018).

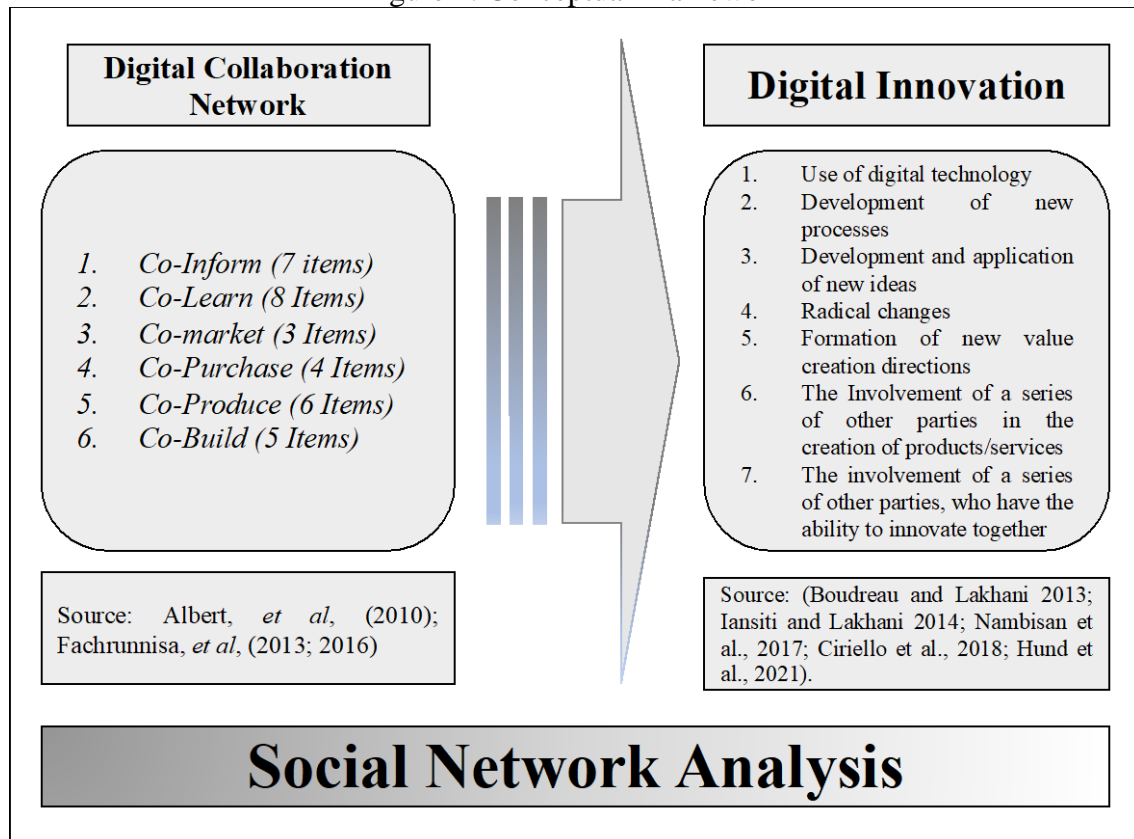
## 2.5 The Relevance Between Digital Collaboration Network and Digital Innovation

Many digital innovations require fundamentally different capabilities since entrepreneurs collaborate with partners who possess the capabilities (Tiwana, 2018; Smailhodžić & Denis Berberović, 2021; Bogers *et al.*, 2022). That is why digital innovation can occur in a collaboration network, a virtual ecosystem for collaborating and building business coalitions in a virtual setting (Fachrunnisa, 2016). Digital innovation often occurs in collaborative networks including a series of actors (L. Li *et al.*, 2022). Digital collaboration network between companies have been recognized to significantly influence innovation, including digital innovation (Das & Teng, 2000; Schilling & Phelps, 2007; Selander *et al.*, 2010). Digital collaboration network offers new and

efficient ways to communicate and interact with customers, suppliers, and other actors concerning service, product development, marketing, recruitment, and shared value creation (Camarinha-Matos & Afsarmanesh, 2005). Considering this, social network analysis and strategic thinking approaches are suitable for exploring the relationships and interdependencies of ecosystem actors in order to create value (Zahra & Nambisan, 2011; Kapoor & Lee, 2013).

The relevance between the variables can be seen in the concept framework in figure 1 below:

Figure 1. Conceptual Framework



### 3. METHODS

This research uses mixed methods with an exploratory sequential strategy. The population is digital entrepreneurs in West Java who are recorded in (<https://www.startupranking.com/top/jawa-barat>), MKTI, and the Hands Above Business Community. Meanwhile, the respondents are selected by purposive sampling based on certain characteristics and traits of the population (Sekaran & Bougie, 2016), namely:

1. MSMEs have been established for at least one year
2. MSMEs that have used technology in business operations deserve to be called digital entrepreneurs
3. Digital entrepreneur MSMEs located in West Java

The sample size is determined by the number of responses generated by the questionnaires from the total distributed to all respondents. This research includes 110

respondents who met the characteristics and responded by filling out a complete questionnaire.

This research uses regression testing to test the relevance of digital collaboration networks and digital innovation variables. A validity and reliability test was conducted prior to testing. The purpose of the validity test is to ascertain the validity of the data collected from the distribution of questionnaires that have been completed and will be processed. The test calculation involves looking at the significance threshold of 5%/0.05,  $df\ n-2$ , and  $R\ count \geq R\ table$ . The Reliability test follows. This test uses Cronbach's Alpha formula to determine whether the data is trustworthy.

The determination of actors in the digital collaboration network is based on the individual-level approach. Therefore, the network structure is developed based on the perspective of Digital Entrepreneur MSMEs as business actors. To determine the most important actors in the digital collaboration network, an SNA theory approach is adopted using the Gephi 9.2 application with questionnaire result data. Gephi is a visualization and exploration tool for all types of graphics and networks (Bastian *et al.*, 2009). For the concept of SNA, the dimension used is centrality, which is commonly adopted in network theory (Neumeyer & Santos, 2018). Moreover, dimensions are used to define central nodes or actors in a network, including centrality (degree centrality, closeness centrality, betweenness centrality, and eigenvector), to identify actors that influence or have high interaction value (Setatama & Tricahyono, 2017). The questionnaire data is processed using the SPSS application, which develops into laboratory data. Subsequently, the results are processed using the Gephi 9.2 application to produce network structures, which are analyzed by descriptive methods. The formation of clear data carries out the validity, the use of various sources, as well as different collection and analysis techniques.

#### 4. RESULTS AND DISCUSSION

This section explains the analysis of digital collaboration network for digital innovation and the digital collaboration network in the digital innovation context of digital entrepreneur in West Java based on the SNA approach.

##### 4.1 Digital Collaboration Network for Digital Innovation on Digital Entrepreneurs in West Java

As explained in the methodology, the validity test's findings are listed below.

Table 1. Validity Test Result

Variable	Indicator	R Count	R Table	Results
Digital Collaboration Network (X)	DCNI1	0.544677	0.1865	Valid
	DCNI2	0.558948	0.1865	Valid
	DCNI3	0.551803	0.1865	Valid
	DCNI4	0.56152	0.1865	Valid
	DCNI5	0.593622	0.1865	Valid
	DCNI6	0.602238	0.1865	Valid
	DCNI7	0.565024	0.1865	Valid
	DCNL1	0.64508	0.1865	Valid
	DCNL2	0.79479	0.1865	Valid

Variable	Indicator	R Count	R Table	Results
	DCNL3	0.68875	0.1865	Valid
	DCNL4	0.798791	0.1865	Valid
	DCNL5	0.857807	0.1865	Valid
	DCNL6	0.782773	0.1865	Valid
	DCNL7	0.782889	0.1865	Valid
	DCNL8	0.774616	0.1865	Valid
	DCNM1	0.80527	0.1865	Valid
	DCNM2	0.790783	0.1865	Valid
	DCNM3	0.653591	0.1865	Valid
	DCNP1	0.793777	0.1865	Valid
	DCNP2	0.834625	0.1865	Valid
	DCNP3	0.811616	0.1865	Valid
	DCNP4	0.812285	0.1865	Valid
	DCNPR1	0.7919	0.1865	Valid
	DCNPR2	0.795107	0.1865	Valid
	DCNPR3	0.806578	0.1865	Valid
	DCNPR4	0.712836	0.1865	Valid
	DCNPR5	0.648817	0.1865	Valid
	DCNPR6	0.690056	0.1865	Valid
	DCNB1	0.783929	0.1865	Valid
	DCNB2	0.734636	0.1865	Valid
	DCNB3	0.770959	0.1865	Valid
	DCNB4	0.822347	0.1865	Valid
	DCNB5	0.780573	0.1865	Valid
Digital Innovation (Y)	DI1	0.720246	0.1865	Valid
	DI2	0.842823	0.1865	Valid
	DI3	0.830598	0.1865	Valid
	DI4	0.739364	0.1865	Valid
	DI5	0.776333	0.1865	Valid
	DI6	0.804009	0.1865	Valid
	DI7	0.72589	0.1865	Valid

The Digital Collaboration Network (X) and Digital Innovation (Y) variables were found to meet the validity requirements based on the test findings. This demonstrates that all survey data for every variable has been deemed legitimate and is ready for additional testing.

The reliability test results are listed below.

Table 2. Realibility Test Result

Variable	Cronbach's Alpha	Alpha	Result
<i>Digital Collaboration Network (X)</i>	0.94	0.6	Reliable
<i>Digital Innovation (Y)</i>	0.75	0.6	Reliable

Table 3. Determination Coefficient

Multiple R	0.412332
R Square	0.170018
Adjusted R Square	0.162333
Standard Error	0.630353
Observations	110

The questionnaire data for this study revealed greater than 0.6, according to the reliability test findings, suggesting that The Digital Collaboration Network (X) and Digital Innovation (Y) satisfied the dependability requirements. The R Square value indicates the coefficient of determination's value. It was discovered that the coefficient of determination was 17% based on the previously mentioned data. This indicates that there is a 17% effect of the Digital Collaboration Network (X) on Digital Innovation (Y). The remaining 83%, meanwhile, discussed how additional factors that the researchers had not looked at had an impact. After that, a hypothesis test was conducted, and the outcomes are as follows:

Table 4. Hypothesis Test

ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	8.79058	8.79058	22.12326	0.00001
Residual	108	42.91332	0.397346		
Total	109	51.7039			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
Intercept	2.937621	0.219352	13.39224	0.0000
DCN	0.336026	0.071441	4.703537	0.0000

Based on the results of the simple linear regression test, it was found that:

$$Y = a + bx$$

$$Y = 2.934 + 0.336x$$

The regression analysis reveals that the Digital Collaboration Network (X) positively influences Digital Innovation (Y) with a regression coefficient of 0.336. This suggests that improvements or expansions in digital collaboration networks are directly associated with enhancements in digital innovation. The positive relationship implies that as companies engage more in digital collaboration, their capacity for innovation in digital products and services increases. Furthermore the hypothesis test supports the statistical significance of this relationship. The p-value of 0.0000, which is well below the threshold of 0.05, and the t-statistic of 4.703, which exceeds the critical value of 1.65, both indicate strong evidence against the null hypothesis. Therefore, we reject the null hypothesis and accept the alternative hypothesis, confirming that the Digital Collaboration Network has a significant effect on Digital Innovation.

These findings align with existing theoretical frameworks. Schilling and Phelps (2007) argue that collaboration networks are crucial for innovation, including digital innovation. Digital collaborative network provides access to diverse knowledge and resources,



fostering an environment where new ideas can flourish. However, Das and Teng (2000) and Selander *et al.* (2010) also highlight the potential instability in such networks, which can pose challenges.

## 4.2 Digital Collaboration Network Structure Model Based on Social Network Analysis (SNA) Approach on Digital Entrepreneurs in West Java

The results of analysis using Gephi 9.2 resulted in the following network structure:

### 4.2.1 Degree Centrality

Degree centrality is defined as the number of connections possessed by a node or actor. This structure describes the number of nodes or actors contacted directly by others. Based on laboratory data from the five actors with the highest scores and supported by the degree centrality network structure, Tita Hernawati is the actor with the most connections (29) in the digital collaboration network in West Java.

Table 5. Laboratory Data of Degree Centrality

No	Digital Entrepreneur	Degree Centrality
1	Tita Hernawati	29
2	Muhammad Fikri Fatullah	28
3	Budi Dermawan	28
4	Nadilla Rachma Tria Lestari	27
5	Muhammad Zulfikar Ridho	27

Tita Hernawati (Dapur Tihwa Corporation) is a culinary company that has conducted digital business operations using the website <http://www.icalan.id/m/125>, ready-to-eat packaging products for traditional West Java foods such as black, caring, and tofu meatballs. This company was established in 2015 and served the culinary market through Facebook, Twitter, WhatsApp, Instagram, and marketplace media. Based on data on the processed questionnaire, Tita Hernawati is connected to several other digital entrepreneurs who are also engaged in the culinary field, including Momi most, Ngemih bakar hade, Warnas.id, food court core, and Cuanki cart producers. The corporation also collaborates with incubators, namely Oorange Incubator, Rumah BUMN Bandung, and The Local Enablers.

From the community, Tita Hernawati collaborates with MSMEs to upgrade the services. The corporation does not connect with government actors, universities, customers, banks, and investor actors. However, the network of actors from various categories in the digital collaboration network is high when compared to other entrepreneurs. In digital collaboration network, the role of entrepreneurs as drivers of entrepreneurship strengthens the social environment and concentrates geographically as individuals who follow social situations (Feldman, 2001; Minniti, 2008; Huggins & Williams, 2011). From the connections with the corporation and description of the degree centrality, Tita Hernawati can be understood as the digital entrepreneur actor who has the most contact with others. The corporation can also be implied as the most included actor in the digital collaboration network of West Java.

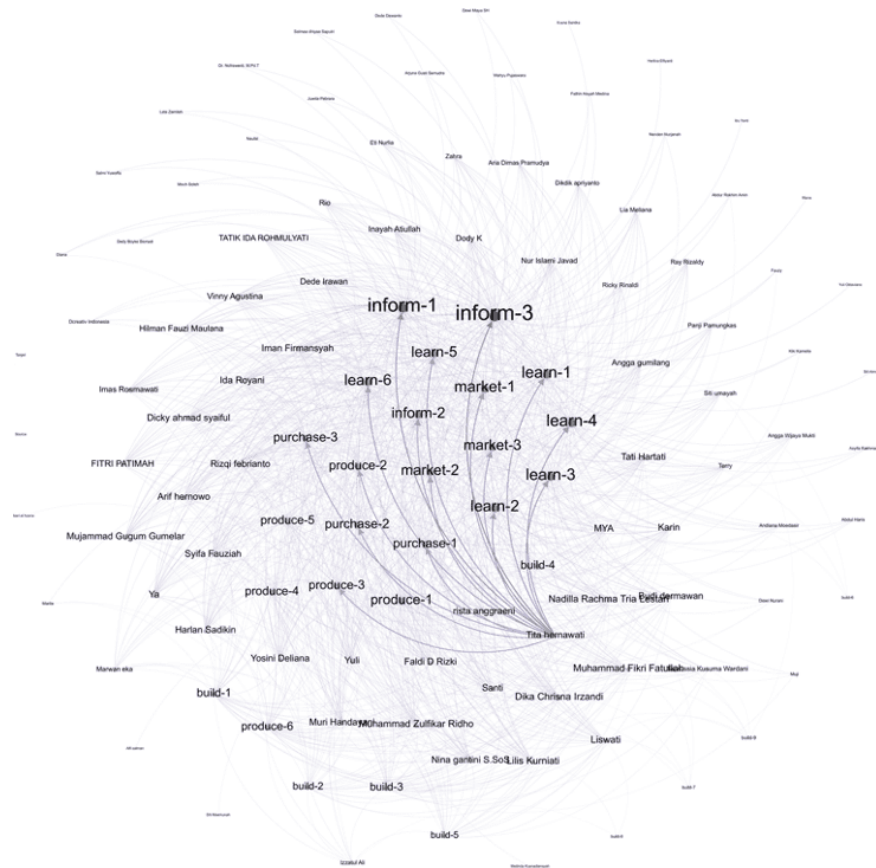


Figure 2. Degree Centrality Network Structure (Visible 10%)  
(Source: Gephi 9.2 Results, 2023)

#### 4.2.2 Closeness Centrality

Closeness centrality is the average shortest path length between a node or actor in the graph. Therefore, an increase in the number of nodes or central actors enhances the proximity to others. Closeness centrality describes the time taken to reach all nodes or actors in the network. Based on laboratory data and supported by the closeness centrality network structure, the actor with the shortest path (Closeness centrality highest (1)) is Tita Hernawati. The corporation has developed into a digital entrepreneur with the best ability to disseminate knowledge and information to all actors.

The issue of collaboration networks in digital entrepreneurs shows that innovations cannot be developed in isolation because the process is complex and non-linear (Walrave *et al.*, 2018). The size and limited resources increase the vulnerability of forming strong bonds with different actors to overcome internal limitations and create shared value (Liliya & Olena, 2021; Marcon & Ribeiro, 2021). This is because digitalization affects entrepreneurial outcomes and processes, provides greater flexibility and the ability to redefine value propositions (Nambisan *et al.*, 2017), and establishes innovation paths (Centobelli *et al.*, 2021).

Table 6. Laboratory Data of Closeness Centrality

No	Digital Entrepreneur	Closeness Centrality
1	Tita Hernawati	1.0
2	Nadilla Rachma Tria Lestari	0.9
3	Muhammad Fikri Fatullah	0.8
4	Rista Anggraeni	0.8
5	Faldi D Rizki	0.8

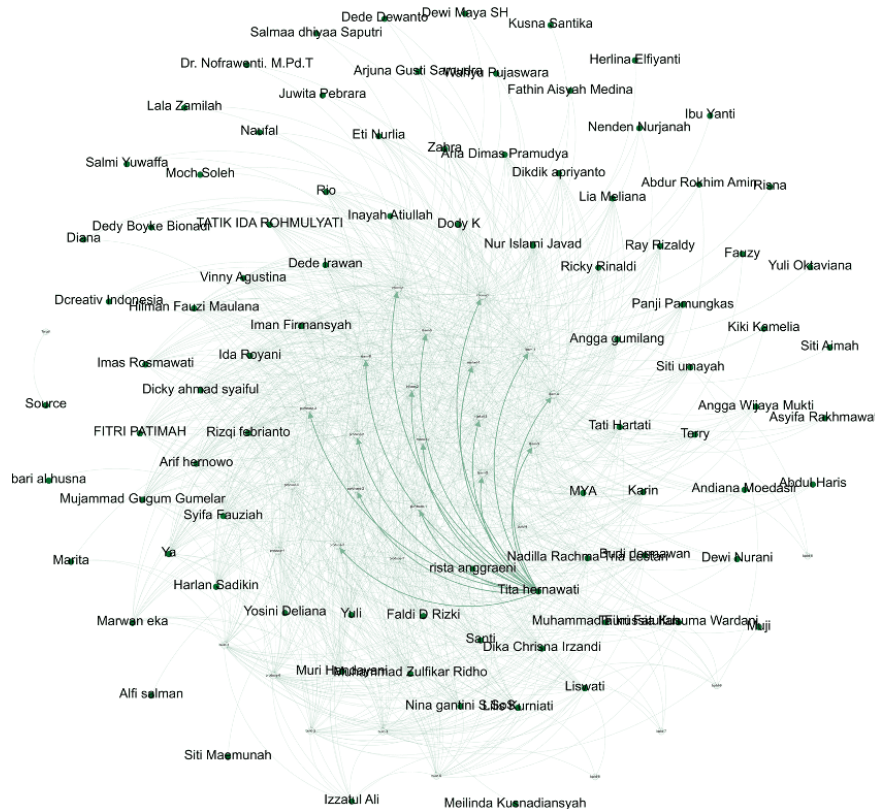


Figure 3. Closeness Centrality Network Structure (Visible 10%)  
(Source: Gephi 9.2 Results, 2023)

**4.2.3 Betweenness Centrality**

Betweenness centrality is a measure of centrality in a graph based on the shortest path by counting the number of times a node acts as an intermediary with the shortest path between two other nodes. Based on laboratory data, the actor having the most direct route between two nodes in the network is Tita Hernawati with the highest betweenness centrality rate of 7586.3. Therefore, the corporation is a digital entrepreneur actor with the most direct mediation between two nodes.

Table 7. Laboratory Data of Betweenness Centrality

No	Digital Entrepreneur	Betweenness Centrality
1	Tita Hernawati	7586,3
2	Nadilla Rachma Tria Lestari	7425,7
3	Muhammad Fikri Fatullah	7138,2
4	Rista Anggraeni	6961,2
5	Faldi D Rizki	6252,8

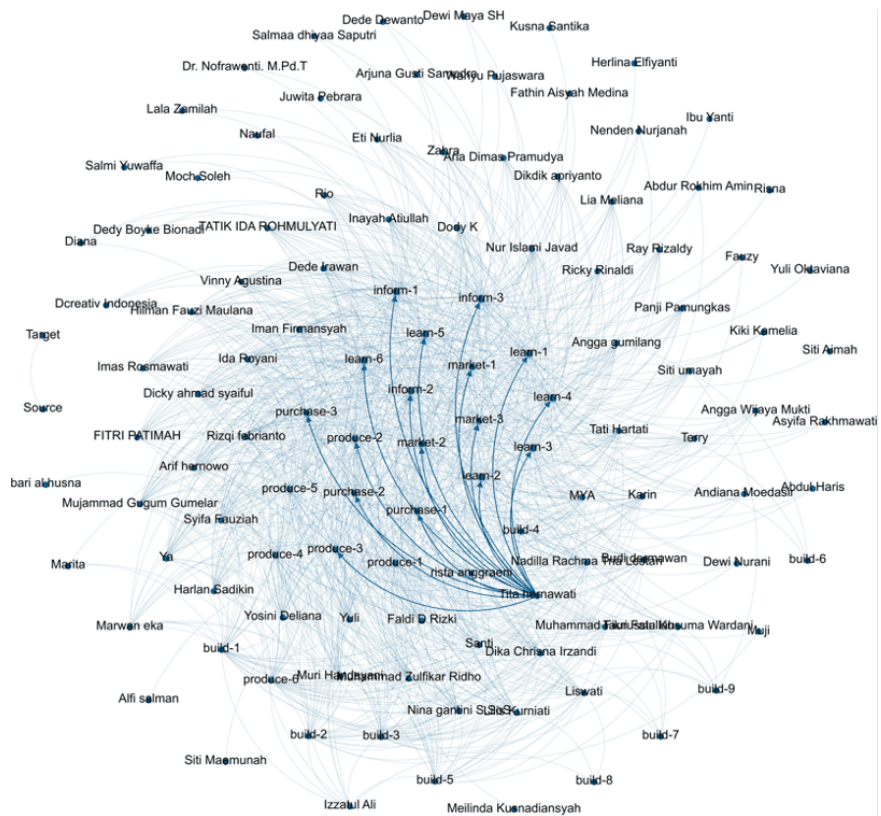


Figure 4. Betweenness Centrality Network Structure (Visible 10%)  
(Source: Gephi 9.2 Results, 2023)

In the digital collaboration network, the position of actors supports the speed of the information and knowledge transformation process. Tita Hernawati is in a position to mediate the two largest number of actors. Therefore, many actors will rely on the corporation in the interaction context to obtain the resources related to digital innovation. Collaboration is important for digital innovation since the process is only possible within the community (Nelson *et al.*, 2018), and many companies in the late 19th century conducted collaborative R&D (L. Li *et al.*, 2022). According to Schumpeter (1934), innovation is the main characteristic of an entrepreneur. Innovation, creativity, and the ability to devise new opportunities are successful acts of entrepreneurship. Therefore, most companies continue to positively impact the economy (Tixier *et al.*, 2018; Azzahra' JOHARI *et al.*, 2021). From the corporation's connections, Tita Hernawati can

be understood as a digital entrepreneur who acts as an intermediary with the most direct path between two actors in the digital collaboration network.

#### 4.2.4 Eigencentrality

Eigencentrality or Eigenvector centrality is a measure of nodes or actors in a network. This measurement describes the suitable connection of these nodes or actors to others. Based on the laboratory data, Tita Hernawati is an actor who has a good connection in the digital collaboration network, with the highest degree eigencentrality (1). Therefore, the corporation, as part of a digital entrepreneur, can be understood as the most important actor in the digital collaboration network.

Table 8. Laboratory Data of Eigencentrality

No	Digital Entrepreneur	Eigencentrality
1	Tita Hernawati	1,00
2	Nadilla Rachma Tria Lestari	0,87
3	Muhammad Fikri Fatullah	0,74
4	Taurussia Kusuma Wardani	0,71
5	Rista Anggraeni	0,70

(Source: Research data, 2023)

This result is validated by the measurement in the previous dimension where Tita Hernawati is an actor with the highest degree centrality compared to others. Based on the questionnaire calculations and the Gephi application, the corporation has the most connections and positions in the digital collaboration network in West Java. In addition, Tita Hernawati has competence capital in creating digital innovations, with factors conducive to the creation of new businesses. The critical role of digital entrepreneurs is the most significant manifestation of entrepreneurship and has the effect of trickling into the structure of the digital innovation network (Zhao & Collier, 2016). Digital entrepreneur competence as human resources is a keyword to gain a competitive advantage in industries with high business competition characteristics and fast-developing technology (Chodorek, 2012). Therefore, the company's ability should be improved to create innovation and creativity through the use of new technology (Rofaida *et al.*, 2019).

In Figure 4, the Co-inform dimension is the most dominating activity carried out by digital entrepreneur actors. Development of organizational capabilities, specifically networking capabilities for value creation, leads to better performance (Srećković, 2018). In addition to forming new networks, companies create new markets for innovation through alliances and collaborative strategies as a way of reducing or eliminating uncertainty or barriers to entry. The digital age is shaping markets and businesses to be interconnected and borderless, where the need for adaptive and innovative business models as well as new and flexible forms of networking is more important (Yaqub *et al.*, 2020).

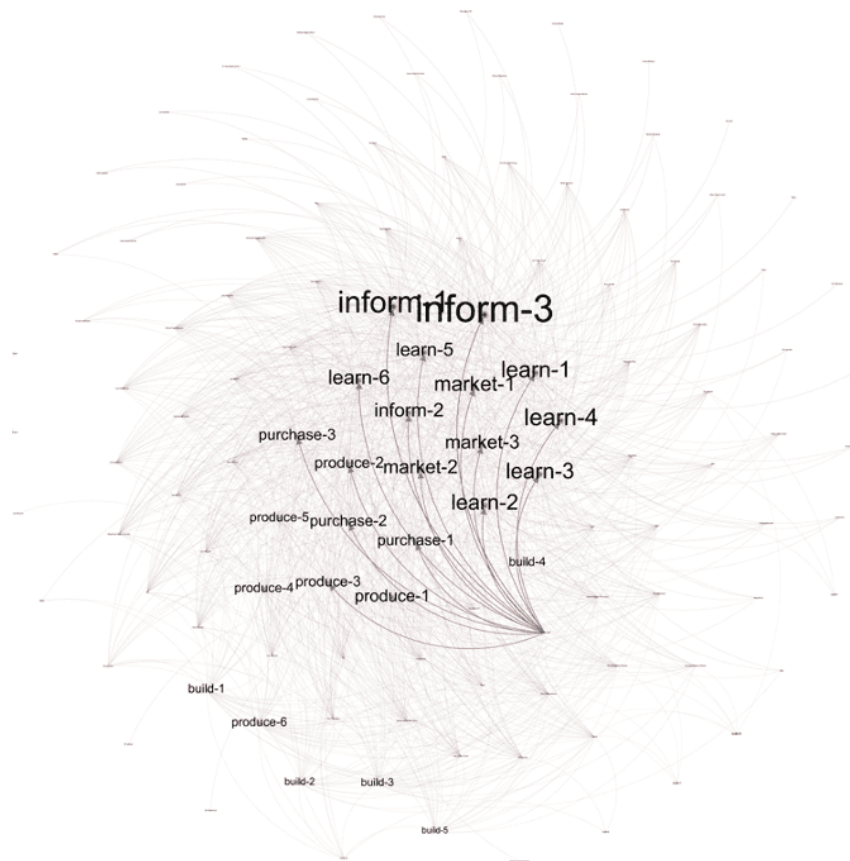


Figure 5. Eigencentality Network Structure (Visible 10%)  
(Source: Gephi 9.2 Results, 2023)

## 5. CONCLUSION AND RECOMMENDATION

In conclusion, the results confirmed that the digital collaboration network significantly affects digital innovation among digital entrepreneurs in West Java. Besides that, most digital entrepreneurs were connected to collaboration in activities to strengthen relationships between suppliers, conduct joint R&D, and build shared foundations, which included activities to build better educational and financial institutions. The results also confirmed that the actor with the most connections and eigencentality in the digital collaboration network was Tita Hernawati. Therefore, the corporation could be considered the digital entrepreneur actor who played the most role in the collaboration network in West Java. Tita Hernawati also had the highest closeness and betweenness centrality values in the structure. Based on the results, several practical suggestions were given to digital entrepreneurs to expand connections in collaborating with the government, universities, community, and information media, specifically on activities to strengthen relationships with networks of technology suppliers and developers. This research contributed to developing scientific knowledge regarding digital entrepreneurship, digital collaboration network, and digital innovation by using a SNA approach. The framework showed the relevance of digital collaboration network and digital innovation, which was developed based on SNA and used as a reference for further analyses. Future research should be conducted to expand the analysis of digital collaboration network by integrating the perspectives of all actors. Therefore, a complete digital collaboration network model could provide a more comprehensive collaboration.

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## REFERENCES

- [1] Albert, Sylvie., Flournoy, D. M., & LeBrasseur, Rolland. (2010). *Networked communities : strategies for digital collaboration*. Information Science Reference.
- [2] Amabile, T. M., Conti, R., Coon, H., Lazenby, J., & Herron, M. (1996). Assessing the work environment for creativity. *Academy of Management Journal*, 39(5), 1154–1184.
- [3] Ancillo, Antonio de Lucas & Gavrilă, Sorin Gavrilă. (2023). The Impact of Research and Development on Entrepreneurship, Innovation, Digitization and Digital transformation, *Journal of Business Research*, Volume 157, 2023.
- [4] Asghari, R., & Gedeon, S. (2010). Significance and impact of Internet on the entrepreneurial process: E-entrepreneurship and completely digital entrepreneurship. *Proceedings of the 4th European Conference on Innovation and Entrepreneurship*.
- [5] Azzahra'JOHARI, Siti Fatimah, Umi Kartini RASHID, Edie Ezwan MOHD SAFIAN, & Juzaimi Nasuredin. (2021). Critical Criteria of Women-Owned SMES Performance Using Multi-Attribute Decision Making (MADM) of Analytical Hierarchy Process (AHP). *Journal of Innovation Management in Small & Medium Enterprises*, 1–15.
- [6] Bastian, M., Heymann, S., & Jacomy, M. (2009). Gephi: an open source software for exploring and manipulating networks. *Proceedings of the International AAAI Conference on Web and Social Media*, 361–362.
- [7] Beliaeva, T., Marcos Ferasso, Sascha Kraus, & Eloi Junior Damke. (2020). Dynamics of digital entrepreneurship and the innovation ecosystem: A multilevel perspective. *International Journal of Entrepreneurial Behavior & Research*, 26(2), 266–284.
- [8] Bharadwaj, A., El Sawy, O. A., Pavlou, P. A., & Venkatraman, N. V. (2013). Digital business strategy: toward a next generation of insights. *MIS Quarterly*, 471–482.
- [9] Biclesanu, I., Anagnoste, S., Branga, O., & Savastano, M. (2021). Digital entrepreneurship: Public perception of barriers, drivers, and future. *Administrative Sciences*, 11(4). <https://doi.org/10.3390/admsci11040125>
- [10] Boudreau, K. J., & Lakhani, K. R. (2013). Using the crowd as an innovation partner. *Harvard Business Review*, 91(4), 60–69.
- [11] Bunduchi, R., Cătălina Crișan-Mitra, Irina-Iulia Salanță, & Emil Lucian Crișan. (2022). Digital product innovation approaches in entrepreneurial firms—the role of entrepreneurs' cognitive frames. *Technological Forecasting and Social*, 175, 121343.
- [12] Camarinha-Matos, L. M., & Afsarmanesh, H. (2005). Collaborative networks: a new scientific discipline. *Journal of Intelligent Manufacturing*, 16, 439–452
- [13] Centobelli, P., Cerchione, R., Esposito, E., Passaro, R., & Shashi. (2021). Determinants of the transition towards circular economy in SMEs: A

- sustainable supply chain management perspective. *International Journal of Production Economics*, 242.
- [14] Chen, Chun-Lung Chen. (2022). Influencing Factors of Information Technology Adoption in Taiwan's SMEs under the Trend of Digital Transformation. *Review of Integrative Business and Economics Research*, Vol. 11, Issue 2, 2022.
- [15] Chodorek, M. (2012). The Place and Role of Talent Management in the Positive Organizational Potential: An Empirical Study of Companies Operating in Poland. *Competition Forum*.
- [16] Ciriello, R. F., Richter, A., & Gerhard Schwabe. (2018). Digital innovation. *Business & Information Systems Engineering*, 60, 563–569.
- [17] Das, T.K., & Teng, B.-S. (2000). Instabilities of Strategic Alliances, *Organization Science* (11:1), pp. 77-101.
- [18] Fachrunnisa, O. (2016). Towards sustainability of virtual business community through trustworthy behaviour-based mechanism. *International Journal of Web Based Communities*, 12(3), 296–322.
- [19] Fachrunnisa, O., Mutamimah, & Gunawan. (2013). Digital collaboration network for SMEs: Awareness of ICT and perceived outcome. *Proceedings - 2013 7th International Conference on Complex, Intelligent, and Software Intensive Systems, CISIS 2013*, 40–46. <https://doi.org/10.1109/CISIS.2013.17>
- [20] Feldman, M. P. (2001). The entrepreneurial event revisited: firm formation in a regional context. *Industrial and Corporate Change*, 10(4), 861–891.
- [21] Giones, F., & Brem, A. (2017). Digital technology entrepreneurship: A definition and research agenda. *Technology Innovation Management Review*, 7(5).
- [22] Grönroos, C., & Voima, P. (2012). *Making sense of value and value co-creation in service logic*. Christian.
- [23] Hair, N., Wetsch, L. R., Hull, C. E., Perotti, V., & Hung, Y.-T. C. (2012). Market orientation in digital entrepreneurship: Advantages and challenges in a web 2.0 networked world. *International Journal of Innovation and Technology Management*, 9(6), 1250045.
- [24] Hoyer, V., & Oliver Christ. (2007). Collaborative e-business process modelling: a holistic analysis framework focused on small and medium-sized enterprises. *Business Information Systems: 10th International Conference (BIS)*, 41–53.
- [25] Huggins, R., & Williams, N. (2011). Entrepreneurship and regional competitiveness: the role and progression of policy. *Entrepreneurship & Regional Development*, 23(9–10), 907–932.
- [26] Hull, C. E. K., Hung, Y.-T. C., Hair, N., Perotti, V., & DeMartino, R. (2007). Taking advantage of digital opportunities: a typology of digital entrepreneurship. *International Journal of Networking and Virtual Organisations*, 4(3), 290–303.
- [27] Hund, A., Heinz-Theo Wagner, Daniel Beimborn, & Tim Weitzel. (2021). Digital innovation: Review and novel perspective. *The Journal of Strategic Information Systems*, 30(4), 101695.
- [28] Iansiti, M., & Lakhani, K. R. (2014). Digital Ubiquity: How Connections, Sensors, and Data Are Revolutionizing Business. *Harvard Business Review*, 92(11), 91–99.



- [29] Ismanu, S., & Kusmintarti, A. (2019). Innovation and firm performance of small and medium enterprises. *Review of Integrative Business and Economics Research*, 8, 312.
- [30] Jack, S., Rose, M., & Johnston, L. (2009). Tracing the historical foundations of social networks in entrepreneurship research. *ISBE Liverpool Annual Conference*.
- [31] Javalgi, R. R. G., Todd, P. R., Johnston, W. J., & Granot, E. (2012). Entrepreneurship, muddling through, and Indian Internet-enabled SMEs. *Journal of Business Research*, 65(6), 740–744.
- [32] Kamberidou, I. (2020). “Distinguished” women entrepreneurs in the digital economy and the multitasking whirlpool. *Journal of Innovation and Entrepreneurship*, 9(1), 3.
- [33] Kapoor, R., & Lee, J. M. (2013). Coordinating and competing in ecosystems: How organizational forms shape new technology investments. *Strategic Management Journal*, 34(3), 274–296.
- [34] Kelestyn, B., & Henfridsson, O. (2014). Everyday digital entrepreneurship: The inception, shifts, and scaling of future shaping practices. *Thirty Fifth International Conference on Information Systems*, 1–8.
- [35] Khanin, D., Robert Rosenfield, Raj V. Mahto, & Cherry Singhal. (2022). Barriers to entrepreneurship: opportunity recognition vs. opportunity pursuit. *Review of Managerial Science*, 16(4), 1147–1167.
- [36] Koch, T., & Windsperger, J. (2017). Seeing through the network: Competitive advantage in the digital economy. *Journal of Organization Design*, 6, 1–30.
- [37] Kraus, S., Carolin Palmer, Norbert Kailer, Friedrich Lukas Kallinger, & Jonathan Spitzer. (2019). Digital entrepreneurship: A research agenda on new business models for the twenty-first century. *International Journal of Entrepreneurial Behavior & Research*, 25(2), 353–375.
- [38] Kraus, S., Jones, P., Kailer, N., Weinmann, A., Chaparro-Banegas, N., & Roig-Tierno, N. (2021). Digital Transformation: An Overview of the Current State of the Art of Research. *Sage Open*, 11(3).
- [39] Kuester, S., Elisa Konya-Baumbach, & Monika C. Schuhmacher. (2018). Get the show on the road: Go-to-market strategies for e-innovations of start-ups. *Journal of Business Research*, 83, 65–81.
- [40] Leong, C., Shan Ling Pan, & Jie Liu. (2016). Digital entrepreneurship of born digital and grown digital firms: comparing the effectuation process of Yihaodian and Suning. *Thirty Seventh International Conference on Information Systems*.
- [41] Letaifa, S. Ben, Edvardsson, B., & Tronvoll, B. (2016). The role of social platforms in transforming service ecosystems. *Journal of Business Research*, 69(5), 1933–1938.
- [42] Li, L., Yang Tong, Long Wei, & Shuili Yang. (2022). Digital technology-enabled dynamic capabilities and their impacts on firm performance: Evidence from the COVID-19 pandemic. *Information & Management*, 59(8), 103689.
- [43] Li, W., Du, W., & Yin, J. (2017). Digital entrepreneurship ecosystem as a new form of organizing: the case of Zhongguancun. *Frontiers of Business Research in China*, 11, 1–21.
- [44] Liliya, F., & Olena, L. (2021). Digital innovations in the formation of sustainable development of the infrastructure complex of maritime transport. *XII International Scientific and Technical Conference*, 590–593.

- [45] Lusch, R. F., Stephen L. Vargo, & Anders Gustafsson. (2016). Fostering a trans-disciplinary perspectives of service ecosystems. *Journal of Business Research*, 69(8), 2957–2963.
- [46] Lyytinen, K., Yoo, Y., & Boland Jr, R. J. (2016). Digital product innovation within four classes of innovation networks. *Information Systems Journal*, 26(1), 47–75.
- [47] Marcon, A., & Ribeiro, J. L. D. (2021). How do startups manage external resources in innovation ecosystems? A resource perspective of startups' lifecycle. *Technological Forecasting and Social Change*, 171, 120965.
- [48] McAdam, M., Crowley, C., & Harrison, R. T. (2020). Digital girl: Cyberfeminism and the emancipatory potential of digital entrepreneurship in emerging economies. *Small Business Economics*, 55(2), 349–362.
- [49] Media Indonesia. (2022). *Studi EV-DCI : Daya Saing Digital Daerah Semakin Merata*. <https://mediaindonesia.com/Teknologi/476280/Studi-Ev-Dci-Daya-Saing-Digital-Daerah-Semakin-Merata>.
- [50] Minniti, M. (2008). The role of government policy on entrepreneurial activity: productive, unproductive, or destructive? *Entrepreneurship Theory and Practice*, 32(5), 779–790.
- [51] Nambisan, S., Lyytinen, K., Majchrzak, A., & Song, M. (2017). Digital innovation management. *MIS Quarterly*, 41(1), 223–238.
- [52] Nambisan, S., Lyytinen, K., & Yoo, Y. (2020). Digital innovation: towards a transdisciplinary perspective. In *Handbook of digital innovation* (pp. 2–12). Edward Elgar Publishing.
- [53] Nasiri, M., Ukko, J., Saunila, M., Rantala, T., & Rantanen, H. (2020). Digital-related capabilities and financial performance: the mediating effect of performance measurement systems. *Technology Analysis & Strategic*, 32(12), 1393–1406.
- [54] Nelson, R. R., Dosi, G., Helfat, C. E., & Pyka, A. (2018). *Modern evolutionary economics: An overview*. Cambridge University Press.
- [55] Neumeyer, X., He, S., & Santos, S. C. (2017). The social organization of entrepreneurial ecosystems. *IEEE Technology & Engineering Management Conference (TEMSCON)*, 1–6.
- [56] Neumeyer, X., & Santos, S. C. (2018). Sustainable business models, venture typologies, and entrepreneurial ecosystems: A social network perspective. *Journal of Cleaner Production*, 172, 4565–4579.
- [57] Ngoasong, M. Z., Lamptey, R. O., & Njinyah, S. Z. (2018, November 8). Digital business incubators and development-led entrepreneurship: A focus on entrepreneurial path creation. *ISBE Conference*.
- [58] Nikolova-Alexieva, V., & Angelova, M. (2019). Digital Entrepreneurship: Doing Business for Smart and Sustainable Bio-Based Economy. *IOP Conference Series: Materials Science and Engineering*, 012081.
- [59] Onetti, A., Zucchella, A., Jones, M. V., & McDougall-Covin, P. P. (2012). Internationalization, innovation and entrepreneurship: business models for new technology-based firms. *Journal of Management & Governance*, 16, 337–368.
- [60] Oshima, Y., & Toma, T. (2023). The Product Innovation Process with the Use of Mediators for Collaboration: The Case of Japanese Traditional Local Industry. *Review of Integrative Business and Economics Research*, 12(3), 50–69.

- [61] Purbasari, R., Enjat Munajat, & Farisadri Fauzan. (2023). Digital Innovation in the Digital Innovation Ecosystem: A Digital Collaboration Networks Approach. *Review of Integrative Business and Economics Research*, 12(3), 200–216.
- [62] Purbasari, R., Wijaya, C., Rahayu, N., & Maulina, E. (2018). Creative industry mapping in East Priangan region: Identifying of local competitive advantage. *AdBispreneur: Jurnal Pemikiran Dan Penelitian Administrasi Bisnis Dan Kewirausahaan*, 3(1), 1–11.
- [63] Ravichandran, T. (2018). Exploring the relationships between IT competence, innovation capacity and organizational agility. *The Journal of Strategic Information Systems*, 27(1), 22–42.
- [64] Rizaty, M. A. (2021). *Terbanyak Nasional, Jumlah UMK Makanan dan Minuman Jawa Barat Capai 791,4 Ribu*. <https://Databoks.Katadata.Co.Id/Datapublish/2021/08/23/Terbanyak-Nasional-Jumlah-Umkmakanan-Dan-Minuman-Jawa-Barat-Capai7914-Ribu>.
- [65] Rofaida, R., Aryanti, A. N., & Perdana, Y. (2019). Strategi inovasi pada industri kreatif digital: Upaya memperoleh keunggulan bersaing pada era Revolusi Industri 4.0. *Jurnal Manajemen Dan Keuangan*, 8(3), 402–414.
- [66] Sahut, J.-M., Luca Iandoli, & Frédéric Teulon. (2021). The age of digital entrepreneurship. *Small Business Economics*, 56(3), 1159–1169.
- [67] Sahut, J.-M., Peris-Ortiz, M., & Teulon, F. (2019). Startups and SMEs experiencing strong growth or hypergrowth: Understanding the issues and the reasons behind their performance. *Revue de L'Entrepreneuriat/Review of Entrepreneurship*, 18(2), 7–19.
- [68] Sandberg, J., Holmström, J., & Lyytinen, K. (2020). Digitization and phase transitions in platform organizing logics: Evidence from the process automation industry. *Management Information Systems Quarterly*, 44(1), 129–153.
- [69] Satalkina, L., & Steiner, G. (2020). Digital entrepreneurship: a theory-based systematization of core performance indicators. *Sustainability*, 12(10), 4018.
- [70] Schumpeter, J. A. (1926). *The Theory of Economics Development: An Inquiry into Profits, Capital, Credit, Interest and the Business Cycle*. Cambridge, Harvard University Press.
- [71] Schilling, M.A., & Phelps, C.C. (2007). Interfirm Collaboration Networks: The Impact of Large-Scale Network Structure on Firm Innovation, *Management Science* (53:7), pp. 1113-1127.
- [72] Schumpeter, J. (1934). *The theory of economic development*. Harvard University Press.
- [73] Seda GÜGERÇİN, & O. N. A. N. Gaye. (2021). Digital Entrepreneurship: A literature review. *EUropean Journal of Managerial Research (EUJMR)*, 5(9), 291–305.
- [74] Sekaran, U., & Bougie, R. (2016). *Research methods for business: A skill building approach*. John Wiley & Sons.
- [75] Selander, Lisen, Henfridsson, Ol & Svahn, Fredrik. (2010). Transforming Ecosystem Relationships In Digital Innovation. *ICIS 2010 Proceedings*. 138
- [76] Setatama, M. S., & Tricahyono, D. (2017). Implementasi social network analysis pada penyebaran country branding wonderful indonesia. *Indonesia Journal on Computing (Indo-JC)*, 2(2), 91–104.

- [77] Shen, F., Jie Li, & Gong Sun. (2023). The impact of ICT use on entrepreneurial performance: evidence from Chinese microenterprises. *Asia Pacific Business Review*, 29(4), 950–966.
- [78] Soetanto, D., & Marina Van Geenhuizen. (2015). Getting the right balance: University networks' influence on spin-offs' attraction of funding for innovation. *Technovation*, 36, 26–38.
- [79] Soltanifar, M., Hughes, M., O'Connor, G., Covin, J. G., & Roijakkers, N. (2023). Unlocking the potential of non-managerial employees in corporate entrepreneurship: a systematic review and research agenda. *International Journal of Entrepreneurial Behavior & Research*, 29(11), 206–240.
- [80] Srećković, M. (2018). The performance effect of network and managerial capabilities of entrepreneurial firms. *Small Business Economics*, 50, 807–824.
- [81] Tiwana, A. (2018). Platform synergy: Architectural origins and competitive consequences. *Information Systems Research*, 29(4), 829–848.
- [82] Tixier, J., Loi, M., Le Pontois, S., Tavakoli, M., & Fayolle, A. (2018). 4 Entrepreneurship education effectiveness. *International Enterprise Education: Perspectives on Theory and Practice*.
- [83] Vasilchenko, E., & Morrish, S. (2011). The role of entrepreneurial networks in the exploration and exploitation of internationalization opportunities by information and communication technology firms. *Journal of International Marketing*, 19(4), 88–105.
- [84] Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *Journal of Strategic Information Systems*, 28, 118–144.
- [85] Walrave, B., Talmar, M., Podoyntsyna, K. S., Romme, A. G. L., & Verbong, G. P. (2018). A multi-level perspective on innovation ecosystems for path-breaking innovation. *Technological Forecasting and Social Change*, 136, 103–113.
- [86] Wang, P. (2021). Connecting the parts with the whole: Toward an information ecology theory of digital innovation ecosystems. *Mis Quarterly*, 45(1).
- [87] Yaqub, M. Z., Marijana Srećković, Gérard Cliquet, George Hendrikse, & Josef Windsperger. (2020). Network innovation versus innovation through networks. *Industrial Marketing Management*, 90(2020), 79–89.
- [88] Zahra, S. A., & Nambisan, S. (2011). Entrepreneurship in global innovation ecosystems. *AMS Review*, 1, 4–17.
- [89] Zhao, F., & Collier, A. (2016). Digital entrepreneurship: Research and practice. *9th Annual Conference of the EuroMed Academy of Business*, 2173–2182.