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The Influence of Digital Leadership and Innovation on Sustainable Village Development

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Abstract

Village development is the foundation of the country's development. Sustainable village development has become a major focus in various global and national development agendas. Sustainable village development is an approach that will bring villages towards economic, social and environmental improvement and balance. The purpose of the study was to analyze the influence of digital leadership and innovation on sustainable village development. The research was conducted in 105 (one hundred and five) independent villages on the Village Development Index (IDM) in Lampung province in 2022 from March to May 2025 with respondents Village Head and Village Secretary. Data collection through Google Form (GF) questionnaire. Data analysis using Structural Equation Modeling (SEM) with SmartPLS application. The results showed that digital leadership has a significant influence on innovation. Digital leadership has an insignificant influence on sustainable village development. Innovation has a significant influence on sustainable village development. Digital leadership has an influence on sustainable village development with the mediator of innovation. The government builds digital access infrastructure and digital literacy of rural communities to create village innovation for sustainable village development.

Keywords: Digital Leadership, Innovation, Village, Sustainable Development

1. Introduction

The village government has a very strategic role in organizing village governance to carry out development and public services to the community. The village government has roles and duties, among others, as a coach and implementer of policies and programs (Syaifudin and Ma'ruf, 2022) [40], the main driver of e-government implementation in realizing transparency in village governance (Pertiwi *et al*., 2021) [26], community empowerment through the formation of policies, strategies, and communication (Hayati, 2021 and Dharma *et al*., 2022) [14, 6].

Village governments are able to encourage community participation in village development through community coaching, building community capacity and encouraging decision-making processes through village meetings (Samaun *et al*., 2022) [32] and building cooperation with community institutions (Suhaira *et al*., 2022). Village governments can also maintain economic stability and the welfare of their citizens through community empowerment (Ticoalu *et al*., 2022) [42]. The village government can cooperate with the community in developing the village to improve the standard of living of the village community (Akbar and Fauzi, 2022) [2].

However, village governments in Indonesia are still faced with various obstacles and problems, including village governments not being able to be accountable for reporting the use of village finances (Samaun *et al*., 2022) [32], constrained in the managerial and management of village organizations (Taufik *et al*., 2022) [41], unable to formulate and formulate disaster risk reduction regulations at the village level with support and awareness from the community (Utama *et al*, 2020) [44], lack of skills and understanding in financial management, village officials are still busy with their own affairs and community involvement is still lacking (Setiawan *et al*., 2022) [35], lack of follow-up and socialization of development programs, lack of community participation, allocation of funds, and the absence of institutions (Syaifudin and Ma'ruf, 2022) [40].

Village development is the foundation of state development in improving the quality of life and welfare of citizens. Sustainable rural development has become a major focus in various global and national development agendas. Villages as the smallest unit of government have an important role in realizing the welfare of society as a whole. In this era of rapid development of information technology, digital leadership and innovation are key factors that can affect organizational sustainability. Various

studies have been conducted to determine the role of digital leadership and innovation in creating sustainable organizations. Previous research shows that research on sustainable organizations is influenced by digital leadership (Retnowati and Santosa, 2023) [29], (Khaw *et al.,* 2022) [17], (Pham and Vu, P. K. (2022) [27] and innovation (Yiğit, 2020) [48] (Silvestre and Ţîrcă, 2019) [36], (Lejbert,and Kovyazin, 2022) [20], (Lazaretti *et al.,* 2020) [19], (Stojanova *et al.,* 2022) [37] (Cuong *et al.,* (2021) [4].

A sustainable village is defined as a village that is able to manage its natural resources and environment sustainably, provide adequate basic services, and have a high level of welfare for its residents (World Bank, 2021) [46]. The importance of learning organizations in improving the capacity and capability of village human resources has been recognized in various studies (Senge, 1990) [34]. Effective digital leadership also plays an important role in adapting technology and innovation to improve the efficiency and effectiveness of public services (Westerman *et al*., 2014) [45]. In addition, innovations in various aspects of village life can drive local economic growth and improve people's quality of life (Rogers, 2003) [30].

Sustainable village development is in accordance with the Village Development Index (IDM) due to the similarity of three (3) indicators of development sustainability with the composite index that is the basis for determining village status, namely economic, social and environmental (ecological) indicators. In the Regulation of the Minister of Villages, Development of Disadvantaged Regions and Transmigration of the Republic of Indonesia number 2 of 2016 concerning the Village Development Index, it is explained that the Village Development Index (IDM) is a composite index assessed through three resilience index measurements in the fields of: (1) social, (2) economic and (3) environmental or ecological. Based on these three indices, villages are then categorized into five village statuses, namely (1) very underdeveloped, (2) underdeveloped, (3) developing, (4) developed and (5) independent.

(https://idm.kemendesa.go.id/view/detil/1/tentang-idm).

Based on the progress data of the Village Development Index (IDM) in 2022 published by the Lampung Province Village Community Empowerment and Transmigration Office, out of a total of 2,435 villages in Lampung Province, there are 38 underdeveloped villages, 1,489 developing villages, 803 developed villages and 105 independent villages (Table 1).

Table 1: Recap of Lampung Province IDM Status in 2022

S. No	Kabupaten	Kecamatan	Village	Status IDM				
				Very Underdeveloped	Underdeveloped	Developing	Developed	Independent
1	Lampung Selatan	17	256	0	1	165	90	0
2	Lampung Tengah	28	301	0	0	138	147	16
3	Lampung Utara	23	232	0	2	194	36	0
4	Lampung Barat	15	131	0	0	21	63	47
5	Tulang Bawang	15	147	0	3	107	33	4
6	Tanggamus	20	299	0	3	220	76	0
7	Lampung Timur	24	264	0	4	160	96	4
8	Way Kanan	15	221	0	2	155	54	10
9	Pesawaran	11	144	0	0	103	31	10
10	Pringsewu	9	126	0	0	32	82	12
11	Mesuji	7	105	0	9	51	45	0
12	Tulang Bawang Barat	9	93	0	0	64	28	1
13	Pesisir Barat	11	116	0	14	79	22	1
Jumlah		**204**	**2435**	**0**	**38**	**1489**	**803**	**105**

Source: Department of Village Community Empowerment and Transmigration of Lampung Province in 2022

From this data, it can be seen that 63% (1,527) of villages in Lampung province are still in the underdeveloped and developing categories, 32.9% (803) villages are included in the developed village status and only 4.3% (105) villages are classified as independent villages. Independent village status in IDM has indicators similar to sustainable development which aims for villages to have values and culture, independence, and sustainability from three main aspects, namely social, economic, and ecological aspects. Independent village status is a village that has met the highest composite index of social, economic, and ecological (environmental) indices. On this basis, the researcher took an independent village as the research location point because it has fulfilled the indicators of sustainable development which is also based on social, economic and environmental aspects.

Much research on digital leadership has been conducted in educational institutions (Filho *et al*., 2018) [9], (Firmansyah *et al*., 2022) [10] and companies (Malik and Garg, 2020) [21], (Chen *et al*., 2018) [3]. There is still not much research on digital leadership in public institutions, especially village governments. Research on existing village innovations, including those related to village public service innovation (Heri *et al*., 2022) [15], (Idwar, 2022) [16], (Muhammad, 2022) [22], (Lambuaso, 2020) [18] and village innovation actors (Rahmawati, 2022) [28], all of which use a qualitative approach. There has not been much research on village innovation combined with digital leadership variables with a quantitative approach. This research will describe sustainable village development in terms of digital leadership and innovation as a form of village government organizational transformation.

This study aims to test and analyze the influence of digital leadership and innovation on sustainable village development through the questions: (1). Does digital leadership have a significant effect on innovation? (2). Does digital leadership have a significant effect on sustainable village development? (3) Does innovation have a significant effect on sustainable village development? and (4) Does innovation mediate the effect of digital leadership on sustainable village development?

From the literature review above, the research framework can be described as follows (Fig 1).

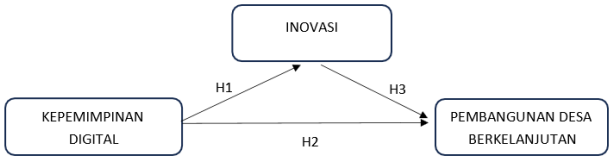

Fig 1: Research framework

2. Research Methods

The population in this study included all villages in Lampung Province, totaling 2,435 villages. The sample selection was conducted using purposive sampling method, which is a sampling technique with certain considerations. In this case, the main consideration was the special criteria of independent village status based on IDM. This selection was done to ensure that the villages included in the study met certain criteria relevant to the research objectives (Tongco, 2007) [43].

This research was conducted in 105 (one hundred and five) villages with independent village status on the Village Development Index (IDM) list spread across 9 districts in Lampung province from March to May 2025. Respondents were 2 (two) people per village consisting of the Village Head and Secretary, with a total of 105 villages x 2 people = 210 respondents.

The names of the villages that will be used as research objects are as shown in Table 2 below.

Table 2: Location of Research Villages

S. No	NAMA KABUPATEN	NAMA KECAMATAN	VILLAGE	IDM VALUE
1	LAMPUNG TENGAH	KALIREJO	KALIREJO	0.837
2	LAMPUNG TENGAH	KALIREJO	PONCO WARNO	0.824
3	LAMPUNG TENGAH	BANGUN REJO	BANGUN REJO	0.827
4	LAMPUNG TENGAH	TRIMURJO	PUJO KERTO	0.820
5	LAMPUNG TENGAH	PUNGGUR	TANGGUL ANGIN	0.821
6	LAMPUNG TENGAH	SEPUTIH RAMAN	RAMA INDRA	0.824
7	LAMPUNG TENGAH	SEPUTIH RAMAN	RUKTI HARJO	0.820
8	LAMPUNG TENGAH	SEPUTIH BANYAK	TANJUNG HARAPAN	0.822
9	LAMPUNG TENGAH	SEPUTIH SURABAYA	GAYA BARU II	0.818
10	LAMPUNG TENGAH	TERUSAN NUNYAI	BANDAR AGUNG	0.892
11	LAMPUNG TENGAH	TERUSAN NUNYAI	TANJUNG ANOM	0.869
12	LAMPUNG TENGAH	BUMI RATU NUBAN	WATES	0.829
13	LAMPUNG TENGAH	BANDAR MATARAM	JATIDATAR MATARAM	0.827
14	LAMPUNG TENGAH	SENDANG AGUNG	SENDANG AGUNG	0.821
15	LAMPUNG TENGAH	KOTA GAJAH	KOTA GAJAH	0.825
16	LAMPUNG TENGAH	BUMI NABUNG	SRI KENCONO	0.848
17	LAMPUNG BARAT	BALIK BUKIT	GUNUNG SUGIH	0.823
18	LAMPUNG BARAT	BALIK BUKIT	KUBU PERAHU	0.836
19	LAMPUNG BARAT	BALIK BUKIT	SEBARUS	0.840
20	LAMPUNG BARAT	BALIK BUKIT	WATES	0.829
21	LAMPUNG BARAT	SUMBER JAYA	WAY PETAI	0.825
22	LAMPUNG BARAT	BELALAU	HUJUNG	0.873
23	LAMPUNG BARAT	BELALAU	KEJADIAN	0.863
24	LAMPUNG BARAT	BELALAU	KENALI	0.820
25	LAMPUNG BARAT	WAY TENONG	KARANG AGUNG	0.842
26	LAMPUNG BARAT	WAY TENONG	PURALAKSANA	0.877
27	LAMPUNG BARAT	WAY TENONG	SUKARAJA	0.817
28	LAMPUNG BARAT	WAY TENONG	TANJUNGRAYA	0.819
29	LAMPUNG BARAT	SEKINCAU	GIHAM SUKAMAJU	0.881
30	LAMPUNG BARAT	SEKINCAU	PAMPANGAN	0.859
31	LAMPUNG BARAT	SEKINCAU	WASPADA	0.827
32	LAMPUNG BARAT	SUOH	BANDING AGUNG	0.849
33	LAMPUNG BARAT	SUOH	RINGIN SARI	0.858
34	LAMPUNG BARAT	SUOH	SUKA MARGA	0.855
35	LAMPUNG BARAT	SUOH	SUMBER AGUNG	0.859
36	LAMPUNG BARAT	SUOH	TUGU RATU	0.881
37	LAMPUNG BARAT	BATU BRAK	PEKON BALAK	0.825
38	LAMPUNG BARAT	SUKAU	TANJUNG RAYA	0.860
39	LAMPUNG BARAT	GEDUNG SURIAN	CIPTAWARAS	0.838
40	LAMPUNG BARAT	GEDUNG SURIAN	GEDUNG SURIAN	0.819
41	LAMPUNG BARAT	GEDUNG SURIAN	PURAMEKAR	0.831
42	LAMPUNG BARAT	GEDUNG SURIAN	TRIMULYO	0.907
43	LAMPUNG BARAT	KEBUN TEBU	MUARA BARU	0.834
44	LAMPUNG BARAT	KEBUN TEBU	MUARA JAYA I	0.841

45	LAMPUNG BARAT	KEBUN TEBU	MUARA JAYA II	0.845
46	LAMPUNG BARAT	KEBUN TEBU	PURA JAYA	0.836
47	LAMPUNG BARAT	KEBUN TEBU	PURA WIWITAN	0.858
48	LAMPUNG BARAT	AIR HITAM	GUNUNGTERANG	0.884
49	LAMPUNG BARAT	AIR HITAM	SEMARANG JAYA	0.865
50	LAMPUNG BARAT	AIR HITAM	SIDODADI	0.867
51	LAMPUNG BARAT	AIR HITAM	SRI MENANTI	0.858
52	LAMPUNG BARAT	AIR HITAM	SUMBER ALAM	0.883
53	LAMPUNG BARAT	PAGAR DEWA	SIDOMULYO	0.827
54	LAMPUNG BARAT	BATU KETULIS	ARGOMULYO	0.828
55	LAMPUNG BARAT	BATU KETULIS	BATU KEBAYAN	0.825
56	LAMPUNG BARAT	LUMBOK SEMINUNG	KEAGUNGAN	0.839
57	LAMPUNG BARAT	LUMBOK SEMINUNG	LOMBOK	0.856
58	LAMPUNG BARAT	LUMBOK SEMINUNG	SUKA BANJAR	0.839
59	LAMPUNG BARAT	LUMBOK SEMINUNG	SUKA MAJU	0.821
60	LAMPUNG BARAT	BANDAR NEGERI SUOH	GUNUNG RATU	0.838
61	LAMPUNG BARAT	BANDAR NEGERI SUOH	SRI MULYO	0.864
62	LAMPUNG BARAT	BANDAR NEGERI SUOH	SUOH	0.880
63	LAMPUNG BARAT	BANDAR NEGERI SUOH	TRI MEKAR JAYA	0.856
64	TULANG BAWANG	BANJAR AGUNG	DWI WARGA TUNGGAL JAYA	0.821
65	TULANG BAWANG	BANJAR AGUNG	TUNGGAL WARGA	0.871
66	TULANG BAWANG	BANJAR MARGO	PENAWAR JAYA	0.847
67	TULANG BAWANG	BANJAR MARGO	PENAWAR REJO	0.854
68	LAMPUNG TIMUR	SUKADANA	SUKADANA ILIR	0.836
69	LAMPUNG TIMUR	SEKAMPUNG	SUMBER GEDE	0.824
70	LAMPUNG TIMUR	SEKAMPUNG UDIK	BANJAR AGUNG	0.836
71	LAMPUNG TIMUR	BANDAR SRIBHAWONO	SRIMENANTI	0.816
72	WAY KANAN	BLAMBANGAN UMPU	BUMI BARU	0.825
73	WAY KANAN	BARADATU	BHAKTI NEGARA	0.847
74	WAY KANAN	BARADATU	GUNUNG KATUN	0.867
75	WAY KANAN	BARADATU	SETIA NEGARA	0.827
76	WAY KANAN	PAKUAN RATU	SERUPA INDAH	0.843
77	WAY KANAN	NEGERI AGUNG	TANJUNG REJO	0.869
78	WAY KANAN	REBANG TANGKAS	GUNUNG SARI	0.822
79	WAY KANAN	REBANG TANGKAS	LEBAK PENIANGAN	0.825
80	WAY KANAN	NEGARA BATIN	NEGARA BATIN	0.839
81	WAY KANAN	BUMI AGUNG	PISANG BARU	0.872
82	PESAWARAN	GEDONG TATAAN	SUKARAJA	0.863
83	PESAWARAN	NEGERI KATON	ROWO REJO	0.911
84	PESAWARAN	TEGINENENG	BATANG HARI OGAN	0.824
85	PESAWARAN	TEGINENENG	TRIMULYO	0.817
86	PESAWARAN	PADANG CERMIN	PADANG CERMIN	0.834
87	PESAWARAN	PUNDUH PIDADA	BANGUN REJO	0.818
88	PESAWARAN	TELUK PANDAN	HANURA	0.959
89	PESAWARAN	WAY RATAI	BUNUT	0.820
90	PESAWARAN	WAY RATAI	GUNUNG REJO	0.851
91	PESAWARAN	WAY RATAI	WATES WAY RATAI	0.972
92	PRINGSEWU	PRINGSEWU	PODOMORO	0.860
93	PRINGSEWU	PRINGSEWU	SIDOHARJO	0.872
94	PRINGSEWU	GADING REJO	TAMBAH REJO BARAT	0.877
95	PRINGSEWU	GADING REJO	TAMBAHREJO	0.898
96	PRINGSEWU	GADING REJO	WATES	0.853
97	PRINGSEWU	GADING REJO	WONODADI	0.914
98	PRINGSEWU	AMBARAWA	AMBARAWA	0.862
99	PRINGSEWU	PAGELARAN	BUMI RATU	0.897
100	PRINGSEWU	PAGELARAN	PAGELARAN	0.829
101	PRINGSEWU	ADILUWIH	ADILUWIH	0.851
102	PRINGSEWU	ADILUWIH	BANDUNG BARU	0.822
103	PRINGSEWU	SUKOHARJO	SUKOHARJO III	0.927
104	TULANG BAWANG BARAT	TULANG BAWANG TENGAH	PULUNG KENCANA	0.834
105	PESISIR BARAT	LEMONG	LEMONG	0.858

Source: Department of Village Community Empowerment and Transmigration of Lampung Province in 2022

Data collection through questionnaires in the form of Google Form (GF) sent to respondents. Data analysis using Structural Equation Modeling (SEM) with the SmartPLS application.

3. Results and Discussion

From the results of this study, the data analysis is as follows:

3.1 Measurement Model Testing (Outer Model)

3.1.1 Convergent Validity

Convergent Validity is a test measurement model that has a value based on the correlation between the item score and the construct value. The criteria in this measurement are measured by the outer loading value. The following are the results of the outer model test which shows the outer loading value using the smartPLS application analysis.

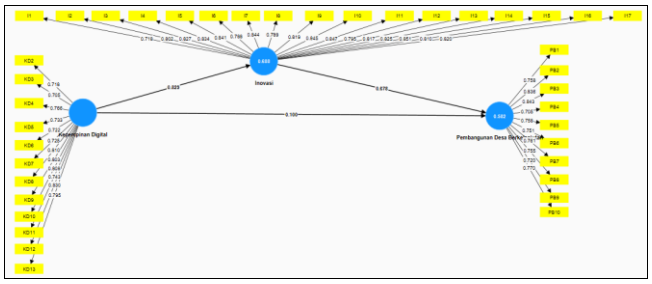

Fig 2: Measurement Model Test Results (Outer Model)

Table 3: Outer Loading Test Results

Latent Variable	Manifest Variables	Loadings Factor	Significance
Digital Leadership	KD2	0.718	Valid
	KD3	0.705	Valid
	KD4	0.766	Valid
	KD5	0.733	Valid
	KD6	0.722	Valid
	KD7	0.725	Valid
	KD8	0.810	Valid
	KD9	0.803	Valid
	KD10	0.808	Valid
	KD11	0.743	Valid
	KD12	0.830	Valid
	KD13	0.795	Valid
Innovation	I1	0.719	Valid
	I2	0.802	Valid
	I3	0.826	Valid
	I4	0.834	Valid
	I5	0.841	Valid
	I6	0.788	Valid
	I7	0.844	Valid
	I8	0.790	Valid
	I9	0.819	Valid
	I10	0.845	Valid
	I11	0.846	Valid
	I12	0.795	Valid
	I13	0.817	Valid
	I14	0.825	Valid
	I15	0.851	Valid
	I16	0.810	Valid
	I17	0.820	Valid
Sustainable Village Development	PB1	0.758	Valid
	PB2	0.836	Valid
	PB3	0.844	Valid
	PB4	0.705	Valid
	PB5	0.759	Valid
	PB6	0.752	Valid
	PB7	0.762	Valid
	PB8	0.756	Valid
	PB9	0.719	Valid
	PB10	0.769	Valid

Source: Processed by researchers, 2025

In Table 3, the results of the outer loading significance test show that all data items in the study have a loading factor value greater than 0.70 (>0.70). This data indicates that all items have a good convergent validity index, meaning that the measures of the construct are highly correlated and it can be concluded that the questionnaire items in this study have good convergent validity.

3.1.2 Discriminant Validity

Discriminant validity is a test conducted to ensure that each concept of each latent variable is different from other variables. The model has good discriminant validity if each loading value of each item of a latent variable has the greatest loading value with other loading values on other latent variables. The results of discriminant validity testing are obtained in Table 4 below:

Table 4: Discriminant Validity

Code	Innovation	Digital Leadership	Sustainable Village Development
I1	0.718	0.651	0.616
I10	0.845	0.699	0.626
I11	0.847	0.738	0.681
I12	0.795	0.694	0.602
I13	0.817	0.675	0.604
I14	0.825	0.622	0.624
I15	0.851	0.674	0.628
I16	0.810	0.708	0.629
I17	0.820	0.667	0.649
I2	0.802	0.665	0.589
I3	0.827	0.710	0.630
I4	0.834	0.709	0.626
I5	0.841	0.709	0.617
I6	0.788	0.647	0.575
I7	0.844	0.690	0.657
I8	0.789	0.598	0.603
I9	0.819	0.631	0.598
KD10	0.644	0.808	0.487
KD11	0.581	0.743	0.454
KD12	0.720	0.830	0.531
KD13	0.699	0.795	0.541
KD2	0.615	0.718	0.541
KD3	0.580	0.705	0.498
KD4	0.618	0.766	0.498
KD5	0.611	0.733	0.517
KD6	0.561	0.722	0.452
KD7	0.603	0.725	0.511
KD8	0.690	0.810	0.543
KD9	0.657	0.803	0.488
PB1	0.573	0.542	0.758
PB10	0.627	0.567	0.770
PB2	0.660	0.567	0.836
PB3	0.657	0.565	0.843
PB4	0.488	0.413	0.705
PB5	0.465	0.379	0.758
PB6	0.557	0.461	0.751
PB7	0.540	0.450	0.761
PB8	0.592	0.480	0.755
PB9	0.621	0.594	0.720

Source: Processed by researchers, 2025

Table 4 above shows that the loading factor for the AVE root value is higher than the correlation between constructs with a cross loading value> 0.70, thus the item is considered valid. The AVE value is above 0.5 or shows that all outer loading variable dimensions have a value> 0.5. In addition, the discriminant validity index from the AVE square root correlation value to the latent construction can be seen that the AVE value is higher than the correlation between other variables, which indicates that the variable is said to have good discriminant validity. Based on the results of the discriminant validity test using cross loading> 0.70 and comparison of the AVE square root correlation between other variables, the variables in this study have a good discriminant validity index.

3.1.3 Composite Reliability

Testing the composite reliability of a construct in SEM-PLS with the SmartPLS application can be done in two ways, namely with Cronbach's Alpha and Composite Reliability. In Table 5 below, it can be seen that all variable values in reliability testing using both Cronbach Alpha and Composite Reliability have values above 0.7 and validity testing using AVE with a value of more than 0.5. Therefore, it can be concluded that the variables tested are valid and reliable, so that structural model testing can be carried out.

Table 5: Reliability Test Results

Variable	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)
Innovation	0.969	0.969	0.971
Digital Leadership	0.935	0.936	0.944
Sustainable Village Development	0.922	0.926	0.934

Source: Processed by researchers, 2025

Composite Reliability can be seen that Cronbach's Alpha and Composite Reliability are greater than 0.7. The results of this data indicate that the research variables are reliable (Yusup, 2018) [49].

3.2 Structural Model Testing (Inner Model)

Structural models are used to test the causal relationships between latent variables. These tests involve the estimation of path coefficients, R-squared (R^2) to measure the predictive power of the model, and statistical tests to determine the significance of the relationships (Chin, 1998). The structural model is evaluated using R-square for dependent constructs, Stone-Geisser Q-square test for Q2 predictive relevance, significance test of structural path parameter coefficients, quality index.

3.2.1 Determination Test (R^2)

The Determination Test (R2) is used to measure the predictive power of the structural model. R-Squares can explain the effect of certain exogenous latent variables on endogenous latent variables that whether they have a substantive effect. The R2 value has a value if $R^2 \geq 0.67$ = strong, if $0.33 \leq R^2 < 0.67$ = moderate and if $R^2 < 0.33$ = weak (Chin, 1998).

Table 6: Determination Test Results (R^2)

Variable	R-square adjusted
Innovation	0.686
Sustainable Village Development	0.578

Source: Processed by researchers, 2025

The value of the coefficient of determination (R2) of the innovation variable in this study is 0.4. Thus it can be concluded that the innovation variable has a strong influence on sustainable village development.

3.2.2 Significance Test (Bootstraping)

Hypotheses can be accepted or rejected by looking at the significance values between constructs, t-statistics and p-values. With this technique, the measurement estimates and standard errors are no longer calculated with statistical assumptions, but are based on empirical observations. The interpretation of the results and conclusions of this study are:

1. If t-statistic > 1.96 and p-value <0.05, then the hypothesis is accepted.
2. If the mediation is significant, then innovation acts as a mediator between digital leadership and sustainable village development.

Table 7: T-Statistic Test Results

Construct	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
KD -> I	0.829	0.830	0.027	30.365	0.000
KD -> PDB	0.100	0.103	0.129	0.778	0.437
I-> PDB	0.678	0.678	0.109	6.221	0.000

Source: Processed by researchers, 2025

Based on the research results in Table 7 t-Statistic results, the research hypothesis can be accepted or rejected explained as follows:

a. Hypothesis 1: The influence of digital leadership on Innovation
   1. Hypothesis 1: There is a significant influence of digital leadership on innovation.

   H_0: There is no effect of digital leadership on innovation.

   H_1: There is a significant influence of digital leadership on innovation.
   2. Criteria: If t-statistic >1.96 96 and p-value <0.05 then H0 is rejected and H1 is accepted.
   3. The results of hypothesis testing show a t-statistic value of 30,365 and p-values of 0.000.
   4. Conclusion:

   Based on the calculation results above, it can be concluded that hypothesis 1 is accepted and stated that there is a significant influence of digital leadership on innovation.

b. Hypothesis 2: The influence of digital leadership on sustainable village development
   1. Hypothesis 2: There is no effect of digital leadership on sustainable village development.

   H_0: There is no effect of digital leadership on sustainable village development.

   H_1: There is a significant influence of digital leadership on sustainable village development.
   2. Criteria: If t-statistic >1.96 96 and p-value <0.05 then H0 is rejected and H1 is accepted.
   3. The results of hypothesis testing show a t-statistic value of 0.778 and p-values of 0.437.
   4. Conclusion:

Based on the results of the above calculations, it can be concluded that hypothesis 2 is rejected and it is stated that there is an insignificant effect of digital leadership on sustainable village development.

c. Hyphotesis 3: The influence of innovation on sustainable village development
   1. Hypothesis 3: There is a significant effect of innovation on sustainable village development
   H_0: There is no effect of innovation on sustainable village development.
   H_1: There is a significant influence of innovation on sustainable village development.
   2. Criteria: If t-statistic >1.96 96 and p-value <0.05 then H0 is rejected and H1 is accepted.
   3. The results of hypothesis testing show a t-statistic value of 6.221 and p-values of 0.000.
   4. Conclusion:
   Based on the results of the above calculations, it can be concluded that hypothesis 3 is accepted and it is stated that there is a significant effect of innovation on sustainable village development.

3.2.3 Mediation Test

Table 8: Mediation Significance Test Results

Kosntruk	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
KD -> I -> PDB	0.631	0.635	0.039	16.050	0.000

Source: Processed by researchers, 2025

Based on the data in Table 8, the t-statistic value of digital leadership on sustainable village development through innovation is 16.050 greater than 1.96 and p-values of 0.000 smaller than 0.05, which means significant. These results indicate that innovation mediates the significant influence relationship between digital leadership and sustainable village development.

3.2.4 Recapitulation of Hypothesis Test Results

Table 9: Hypothesis Test Results

Hypothesis	Description
H1: Digital leadership has a significant influence on innovation	Accepted
H2: Digital leadership has a significant influence on sustainable village development	Rejected
H3: Innovation has a significant influence on sustainable village development	Accepted
H4: Digital leadership has an influence on sustainable village development with innovation as a mediator	Accepted

H1: Digital leadership has a significant influence on innovation.

Digital leadership has a significant influence on innovation based on research data from the t-statistic value of 30.365 greater than 1.96 and p-values of 0.000 smaller than 0.05. So, this data shows that the first hypothesis which states that digital leadership has a significant influence on innovation is proven to be true. Digital leadership implemented by the village government has a significant influence on village innovation.

The results of this study were corroborated by Fitriani *et al*. (2023) [11] who analyzed the role and impact of digital leadership in managing public organizations in the digital era with a qualitative approach using case studies of several public organizations that have implemented digital leadership. The results showed that digital leadership serves as a catalyst in facing the challenges of rapid change in the digital era. Digital leadership encourages public organizations to adopt and implement relevant information technology, and improve digital skills and literacy at all levels. In addition, digital leadership also creates a culture of innovation and collaboration within public organizations. Digital leaders encourage the active participation of staff and organizational members in creating technology-based solutions to improve the quality of public services and operational efficiency. During the digital transformation process, digital leadership also focuses on managing change and overcoming barriers that arise. Digital leaders play an important role in unifying the vision and building commitment to digital transformation, as well as helping to overcome resistance from those less familiar with new technologies. Digital leadership has proven itself as a key factor in managing public organizations in the digital era. Digital transformation led by digital leaders brings positive changes in efficiency, transparency, and public participation in public services. Sugiarto (2024) [38] in his research shows that digital leadership plays an important role in creating innovation through a digital transformation strategy at the East Java High Prosecutor's Office through the SI PANDU application. Digital leadership has three main indicators for innovation, including a deep understanding of people, digitizing the organization, and encouraging and integrating technological trends. These indicators are applied in the East Java High Prosecutor's Office to realize effective public services. The findings in Djabbari's research (2024) [8] show that digital leadership plays an important role in driving government transformation by navigating the complex digital environment and developing a digital mindset. Competencies required for digital leadership include data analysis, strategic thinking, and the ability to inspire and motivate teams. Digital leadership will improve the quality of public services, adapt to rapid technological change and foster an innovative environment.

In sustainable village development research, village innovation will be made possible by the application of digital leadership by village officials. Village officials use digital technology (laptops, LCDs, cellphones, and other devices) to improve services to the community. The use of digital technology equipment creates innovation by applying digital technology and applications in village administration such as Siskeudes (Village Financial System), SIMDESA (Village Management Information System), and Digital Village App (DIGIDES) or others. However, there are several challenges in implementing digital leadership in villages including the quality of village human resources who do not understand digital technology, lack of digital literacy and limited digital technology devices in villages. In addition, there is a lack of support from local and central government in terms of funding, infrastructure and policies that support the implementation of digital systems and technology in villages.

H2: Digital leadership has an insignificant influence on sustainable village development.

The digital leadership construct has no influence on sustainable village development as seen from the t-statistic value of 0.778 which is smaller than 1.96 and p-values of 0.437 greater than 0.05. From this data, it can be concluded that the second hypothesis stating that digital leadership has an insignificant influence on sustainable village development is proven correct. This means that digital leadership carried out by the village government does not directly affect sustainable village development.

The results of this study are supported by Yahya *et al*., (2024) [47] who analyzed the effect of digital leadership on sustainable performance through the mediating role of environmental knowledge sharing and the moderating role of technological innovation. Respondents were 365 district secretariat employees in North Aceh Regency, Bireuen Regency, and Lhokseumawe City, Indonesia, using quantitative methods with Structural Equation Modeling (SEM) using Smart PLS software. The findings of this study indicate that digital leadership significantly impacts environmental knowledge sharing. Although digital leadership does not directly affect sustainable performance significantly, digital leadership and environmental knowledge sharing show a positive and significant influence on sustainable performance. Environmental knowledge sharing significantly mediates the effect of digital leadership on sustainable performance. In addition, technological innovation moderates the relationship between environmental knowledge sharing and sustainable performance. Khaw *et al*. (2022) [17] also supported the results of this study through a literature study of articles in the Scopus scientific database published between 2001 and 2021 with a focus on digital leadership and performance. The findings of his research state that digital leadership does not show a direct influence on sustainable performance. The influence of digital leadership on sustainable performance occurs through mediators such as the spread of digital culture, innovation, or new technology.

The results of this study indicate that digital leadership carried out by the village government does not directly influence sustainable village development. So other mediator variables are needed, among others, through digital cultural transformation, innovation or new technology in village government management to be able to realize sustainable village development. Challenges and obstacles in implementing digital leadership in the village include the lack of digital literacy, for the elderly people are more comfortable and satisfied with manual or face-to-face services, there are still concerns about digital data security, lack of ability to use digital tools and lack of digital training for village communities. In addition, local and central government support in funding and developing digital infrastructure such as weak and unstable internet networks, the availability of digital devices, applicable regulations that are no longer relevant to the needs of the times in the era of digitalization and the absence of standard regulations or guidelines for the application of digital technology in village governments, and the use of digital applications that are not in accordance with the conditions or needs of village operations, complicated and not user-friendly. These challenges are in line with the research findings of Fitriani *et al*. (2023) [11] who identified several challenges in implementing digital leadership in public organizations. Some of these include the lack of adequate resources and budgets, as well as the need to address concerns related to data security and privacy. To address these challenges, governments and public organizations need to invest in human capital training and development, and design policies and strategies that support technological innovation and adaptation to achieve success in digital leadership.

H3: Innovation has a significant influence on sustainable village development.

The innovation construct has a significant influence on sustainable village development according to the research data with a t-statistic value of 6.221 greater than 1.96 and p-values of 0.000 smaller than 0.05. Therefore, the third hypothesis which states that innovation has a significant influence on sustainable village development is proven to be true. This shows that innovations made by the village government through policies, programs and public services to community members will realize sustainable village development.

The results of this study are supported by a study conducted by Ahmad *et al*., (2023) [1] which used the autoregressive distributed lag method on data for 40 years to investigate the impact of technological innovation on sustainable development in China and determine the pathways through which technological innovation contributes to sustainable development obtained empirical results showing that technological innovation is an important driver in promoting sustainable development. Technological innovation is an important driver in promoting sustainable development and augmenting economic growth without harmful effects on the environment. Any strategy that aims for sustainability and efficient use of resources should focus on technological innovation and progress. Therefore, innovation is fundamental to realizing sustainability and improving efficiency. However, innovation for sustainability must be environmentally friendly (e.g., green technology) (Schilirò, 2019) [33].

Innovations carried out in rural areas include social system innovations in the food sector such as the Ecovida Agroecological Network concept in Brazil showing that social innovations in rural food systems can promote sustainable rural development (Rover *et al*., 2016) [31]. There are also smallholder innovations in improving the elements that compose a sustainable system, enabling sustainable land use, ensuring income generation, maintenance of familiarity and structuring of farm work, contributing to the consideration of local knowledge as a major factor in the political promotion of the sustainability of familiarity systems and as a basis for the transition process towards agroecology (Oliveira and Leite, 2010) [23]. In addition, innovation and exploitation of local potential and traditional knowledge can promote sustainable development in the renewable energy sector in Bolivia (Pansera, 2013) [25]. Finally, innovations in agricultural water management can contribute to sustainable rural development in the Lis Valley Irrigation District, Portugal (Oliviera *et al*., 2019). From the results of this study, innovations made by the village government through policies, programs and public services will directly affect sustainable village development. The village government innovates by making improvements to public programs and services while maintaining the values and culture that exist in the village community and the community feels the ease, comfort and satisfaction of

innovations made by the village government so that it has an impact on improving the village's economic, social and environmental conditions.

H4: Digital leadership has an influence on sustainable village development with innovation as a mediator.

The digital leadership construct affects sustainable village development through innovation. This conclusion is indicated by a t-statistic value of 16.050 greater than 1.96 and p-values of 0.000 smaller than 0.05. Thus, the fourth hypothesis stating that digital leadership can realize sustainable village development through innovation is proven correct. This means that digital leadership does not directly lead to sustainable village development, but by encouraging innovation, such as the use of digitalization in village governance and services, it will have a direct impact on sustainable village development.

This result is in accordance with the research of Gariba *et al.* (2024) [12] who used a panel dataset sample of EU countries from 2018 to 2023 using structural equation modeling (SEM) to analyze the direct and indirect impacts of public digitalization and technological innovation on sustainability. The findings in his research state that public digitization positively and significantly influences technological innovation, which in turn drives sustainability progress. His research findings confirm that technological innovation positively mediates the relationship between public digitalization and sustainability. Digital leadership practices by village governments have no direct influence on sustainable village development. The existence of innovation variables connects digital leadership to realize sustainable village development. Village officials who have the capacity of digital leadership and implement it in the activities of the village government organization will give birth to innovation through breakthroughs and new ways that will later realize sustainable village development. The application of digital technology and applications in village government administration such as Siskeudes (Village Financial System), SIMDESA (Village Management Information System), and Digital Village App (DIGIDES) or others are innovations resulting from digital awareness and skills carried out by village governments in administration and public services. These innovations in digital technology will bring villages to sustainable village development in accordance with the times in this digitalization era.

Giovanni and Nurhaida (2024) [13] state that sustainable digital leadership has a significant impact on educational organizations by promoting agility, resilience and adaptability. Digital leadership includes ten essential competencies, including vision focus, repetitiveness, communication and collaboration, flexibility, inventiveness, risk-taking and recovery, critical thinking, learning culture, responsiveness, and creativity and innovation, which empower leaders to effectively implement change. By prioritizing understanding digital change and developing leadership competencies through expert training and support, organizations can enhance their sustainability efforts. Furthermore, providing the necessary resources and a conducive work environment is essential for leaders to collaborate and innovate, ultimately creating a sustainable education ecosystem. The findings of this study expand the understanding of the role of digital leadership in influencing sustainable village development through village innovation. Village governments should prioritize improving and developing the digital leadership competencies of village heads and village officials to create village innovation and sustainable village development.

4. Conclusion and Recommendations

Based on the research results, the following conclusions can be drawn:

1. Digital leadership has a significant influence on innovation. The digital skills of village officials will lead to technological innovation and digital applications in village administration and public services.
2. Digital leadership has an insignificant influence on sustainable village development. Digital leadership in villages still requires digital literacy and skills education as well as local and central government support in funding, digital infrastructure, regulations relevant to the digital era and user-friendly digital applications.
3. Innovation has a significant influence on sustainable village development. Village governments need to be given independence and support from central and local governments in the form of funding, training and regulations that support village innovation.
4. Digital leadership influences sustainable village development through village innovation. Village governments that prioritize improving the digital leadership competencies and skills of village heads and village officials will create innovations that impact sustainable village development.

Researchers provide recommendations from the results of this study are:

1. Encouraging the government to develop village innovations to create sustainable village development
2. Building village innovation ecosystems by involving the participation and collaboration of village governments, communities, the private sector, universities, social institutions and community organizations.
3. Building digital access infrastructure and digital literacy of rural communities.

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