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Bridging the Digital Divide: The Role of Digital Literacy of Coastal Women in Sustainable Development in Tangerang Regency

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Research Article

Keywords: Digital literacy, social capital, coastal women, digital divide, sustainable development, technology acceptance

Posted Date: September 2nd, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10596732/v1

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Additional Declarations: No competing interests reported.

Abstract

This study investigates how digital literacy contributes to sustainable development among coastal women in Tangerang Regency, Indonesia. Specifically, it examines the effects of digital literacy on sustainable development, technology acceptance, and women's empowerment, while assessing the moderating roles of women's empowerment and social capital. A quantitative research design was employed using a survey of 1,108 coastal women selected through probability sampling. Data were analyzed using (PLS-SEM) with SmartPLS 4. The conceptual framework integrates the Capability Approach, Technology Acceptance Model (TAM), Empowerment Theory, and Social Capital Theory. The findings reveal that digital literacy significantly enhances technology acceptance, women's empowerment, and sustainable development. Technology acceptance and women's empowerment also exert positive effects on sustainable development. Moreover, women's empowerment strengthens the relationships between digital literacy and sustainable development and between technology acceptance and sustainable development, while social capital reinforces the influence of women's empowerment on sustainable development. The structural model demonstrates strong predictive capability, explaining 88.0% of the variance in sustainable development ($R^2 = 0.880$). This study advances the digital divide and sustainable development literature by integrating four complementary theoretical perspectives into a unified framework that explains how digital literacy translates into sustainable development through behavioral, empowerment, and community mechanisms. It also provides robust empirical evidence from coastal communities, an underexplored context in digital inclusion research. The findings offer practical insights for policymakers to design integrated digital literacy, women's empowerment, and community-based social capital initiatives that reduce the digital divide and accelerate the achievement of the Sustainable Development Goals (SDGs).

1. Introduction

The digital divide has become an increasingly crucial global issue in the sustainable development agenda, especially in the context of inequalities in access, skills, and use of information technology between different social groups (Alhassan & Adam, 2024; Atobishi & Mansur, 2025; Misra & Srivastava, 2024). Globally, digital transformation has opened up huge opportunities in the fields of economy, education, health, and governance, but these benefits have not been evenly distributed (Djatmiko et al., 2025a; Mwansa et al., 2025). Women, especially those in coastal areas and vulnerable communities, often experience double marginalization due to limited access to technology, low levels of education, and social norms that limit their participation in the digital space (Bhowmik et al., 2025; M. Gupta & Kiran, 2025; Hossain et al., 2025). In the context of sustainable development, digital literacy not only serves as a technical skill, but also as an instrument of socio-economic empowerment that enables women to actively participate in the digital economy, improve family welfare, and contribute to sustainable natural resource management (Lutomia & Bello-Bravo, 2026; Roy et al., 2024; Siphugu & Moloi, 2025). Therefore, the digital literacy of coastal women is a strategic issue in bridging the digital divide while encouraging the achievement of the Sustainable Development Goals (SDGs), especially in the aspects of gender equality, poverty alleviation, and environmental sustainability (Hasmin et al., 2026;

Rahman & Huq, 2023). Figure 1 show Community Literacy Development Index across Banten Province (2023) shows Tangerang Regency at 49.93, indicating moderate performance, slightly below provincial leaders, reflecting structural gaps in literacy access, infrastructure, and community engagement.

In Indonesia, a number of studies show that the digital divide is still a significant challenge, especially in coastal areas and underdeveloped areas (Amni et al., 2026; Nurcahyanto et al., 2025; Sakti et al., 2024; Tua & Gunawan, 2026). Previous studies have revealed that limited infrastructure, low access to digital education, and lack of technology-based training are the main factors that weaken the digital capacity of coastal communities (Hamsiah et al., 2024; Hasmin et al., 2026; Mappatunru et al., 2026). Figure 2 shows that national data shows a difference in the digital literacy index between men and women, where women tend to have lower scores in the aspects of digital skills, digital safety, and digital culture (Kominfo, 2023). In addition, research on coastal women in Indonesia highlights their important role in the economy of fishing families, but still limited access to digital technology that can increase productivity and economic added value (Khan et al., 2026; Leonardi, 2026). Previous studies have also emphasized that digital literacy contributes significantly to improving access to education, employment opportunities, and health services for coastal women (Aslam et al., 2024; Asthana & Prime, 2023; Hasmin et al., 2026). In the context of Tangerang Regency, previous research showed that there is a digital gap in public services and a low community literacy index in the district area compared to urban areas, which indicates a structural disparity in digital-based development (Djatmiko et al., 2025a; Nurcahyo, 2025; Nurrohman et al., 2026).

Although the literature on coastal women's empowerment and digital literacy has evolved, there are still significant research gaps. First, most studies tend to examine the empowerment of coastal women in a sectoral manner, such as economic, social, or environmental, without integrating the digital literacy dimension as a key variable in sustainable development (Aslam et al., 2024; Baker et al., 2024; Mappatunru et al., 2026; Susilowati & Mafruhah, 2023). Second, studies that specifically link coastal women's digital literacy to sustainable development outcomes are still limited, especially in empirical contexts based on quantitative and qualitative data simultaneously (Enayati et al., 2024; Hasmin et al., 2026; Rahman & Huq, 2023). Third, previous research has focused more on national or cross-country areas, so it lacks a deep contextual understanding at the local level (Nurhidayah et al., 2022; Riera-Spiegelhalder et al., 2023; Schneider et al., 2022), especially in the coastal areas of Tangerang Regency which have unique socio-economic and geographical characteristics. Thus, a more comprehensive and integrative research approach is needed to fill these gaps.

This research offers novelty by integrating three main dimensions, namely digital literacy, coastal women's empowerment, and sustainable development in one holistic analytical framework. In contrast to previous studies, this study not only measures the level of digital literacy, but also analyzes how it contributes directly and indirectly to the economic, social, and environmental empowerment of coastal women. In addition, the use of quantitative approach methods with descriptive design of analysis provides advantages in producing findings that are not only statistical, but also contextual and interpretive. Another novelty lies in the specific geographical focus in Tangerang Regency, so that it is

able to make relevant empirical contributions to the formulation of locally-based policies and strengthen digital-based women's empowerment models in coastal areas.

This study aims to analyze the role of digital literacy of coastal women in supporting sustainable development in Tangerang Regency. In particular, this study focuses on: (1) identifying the level of digital literacy of coastal women; (2) analyze the relationship between digital literacy and women's empowerment; and (3) evaluate the contribution of digital literacy to sustainable development in coastal areas. Based on these objectives, the research questions asked are: what is the level of digital literacy of coastal women in Tangerang Regency? How does digital literacy affect the empowerment of coastal women? And what is the role of digital literacy in encouraging sustainable development? To answer this question, this study uses a quantitative method approach with case study, which analysis through a survey of 800 respondents and then strengthened with qualitative analysis through in-depth interviews, observations, and focus group discussions. This approach allows for the integration of statistical data and contextual understanding, resulting in evidence-based policy recommendations in an effort to bridge the digital divide and strengthen the role of coastal women in sustainable development.

2. Literature Review

2.1 Digital Literacy

Digital literacy is widely recognized as a fundamental capability for participating in the digital economy and contemporary society. Beyond technical competence, digital literacy encompasses the ability to access, evaluate, create, and utilize digital information to support economic activities, social interaction, and informed decision-making. From the Capability Approach, digital literacy represents a strategic capability that enables individuals to transform technological resources into valuable opportunities, thereby expanding their freedom and improving their quality of life (Biswas, 2025; Doussard & Yenigun, 2024; Schweiger, 2025). For coastal women, digital literacy is particularly important because it reduces information asymmetry and broadens access to education, markets, financial services, and public programs.

Recent studies consistently demonstrate that digital literacy contributes to women's socio-economic advancement by improving entrepreneurial capacity, financial inclusion, and participation in community development (Fatima et al., 2025; Mishra, Agarwal, et al., 2024; Tamang et al., 2025). Nevertheless, most existing studies focus on urban communities or women entrepreneurs, whereas empirical evidence from coastal women remains relatively limited. Moreover, previous research generally examines digital literacy as an independent predictor without integrating behavioral and empowerment mechanisms that explain how digital competencies ultimately contribute to sustainable development. Building upon the Capability Approach, this study argues that digital literacy functions as the primary capability that enables coastal women to strengthen their empowerment, increase their acceptance of digital technologies, and contribute to sustainable development. Accordingly, digital literacy is positioned as the principal antecedent within the proposed conceptual framework.

Empowerment Theory argues that women become empowered when they possess sufficient resources, agency, and opportunities to make strategic life decisions (Adera & Abdisa, 2023; Mamun & Hoque, 2022). Digital literacy strengthens these dimensions by expanding access to information, improving economic opportunities, and enabling greater participation in household and community decision-making. Previous studies consistently report that women with higher digital literacy demonstrate stronger entrepreneurial capability, broader social participation, and greater economic independence than those with limited digital competencies (Farhan, 2025; Kar et al., 2025; Shukla et al., 2021). However, evidence explaining this relationship within coastal communities remains scarce despite the unique structural challenges faced by coastal women. Therefore, this study proposes that improving digital literacy strengthens women's capability to participate more actively in socio-economic activities, thereby increasing their empowerment.

H1. *Digital literacy positively influences women empowerment.*

According to the Technology Acceptance Model (TAM), technology adoption is influenced primarily by users' perceptions of usefulness and ease of use (Granić, 2024; Taherdoost et al., 2024). Individuals with stronger digital competencies generally possess greater confidence in utilizing digital technologies and experience lower barriers to technology adoption. Empirical evidence confirms that digital literacy significantly enhances technology acceptance across various contexts by improving perceived usefulness, digital self-efficacy, and behavioral intention to use technology (Lin & Yu, 2023; Marikyan et al., 2023). Nevertheless, limited research has examined this relationship among coastal women, whose technology adoption is frequently constrained by geographical isolation and unequal digital access. Accordingly, this study argues that higher digital literacy promotes stronger technology acceptance among coastal women.

H2. *Digital literacy positively influences technology acceptance.*

Digital literacy has increasingly been recognized as an important driver of sustainable development because it facilitates economic inclusion, social participation, and access to essential public services. These capabilities contribute directly to several Sustainable Development Goals (SDGs), particularly poverty reduction, gender equality, and inclusive economic growth (Danladi et al., 2023; Dias, 2021). Previous research indicates that digitally literate women are more capable of improving household welfare, expanding business opportunities, accessing education and healthcare services, and participating in environmental conservation initiatives (Aslam et al., 2024; Ortiz Osejo et al., 2025). However, the direct contribution of digital literacy to sustainable development among coastal women has received limited empirical attention. Based on these arguments, this study proposes that digital literacy contributes positively to sustainable development in coastal communities.

H3. *Digital literacy positively influences sustainable development.*

2.2 Women Empowerment

Women empowerment refers to the process through which women gain greater access to resources, strengthen their agency, and improve their capacity to make strategic decisions affecting their lives. Empowerment extends beyond economic independence to include social participation, leadership, and control over productive resources. According to Empowerment Theory, empowered women are better positioned to influence household welfare, community development, and long-term social transformation (Ogbari et al., 2024; Parwez & Patel, 2022; Tamatur et al., 2026). In coastal communities, empowerment is particularly important because women frequently face structural barriers, including limited educational opportunities, restricted access to productive assets, and unequal participation in local decision-making.

Empirical studies consistently indicate that women's empowerment contributes significantly to sustainable development. Empowered women are more likely to diversify household livelihoods, participate in community organizations, adopt sustainable resource management practices, and improve family resilience against economic and environmental shocks (Jindal, 2025; Selim et al., 2025; Wangendo et al., 2024). Despite these findings, previous studies have predominantly emphasized economic empowerment, while relatively limited attention has been given to empowerment as a multidimensional mechanism supporting sustainable development within coastal communities. Drawing upon Empowerment Theory and previous empirical findings, this study argues that strengthening women's empowerment enables coastal women to participate more actively in economic, social, and environmental development. Therefore, empowered women are expected to contribute more substantially to sustainable development.

H4. *Women empowerment positively influences sustainable development.*

2.3 Technology Acceptance

Technology acceptance reflects an individual's willingness to adopt and continuously use digital technologies to accomplish personal, social, and economic objectives. The Technology Acceptance Model (TAM) explains that users are more likely to adopt digital technologies when they perceive them as useful and easy to use, whereas the Diffusion of Innovation (DOI) Theory emphasizes the importance of communication processes and social environments in accelerating technology adoption (Al-Rahmi et al., 2021; Lampo, 2023; Uyob et al., 2023). Together, these perspectives suggest that technology acceptance represents a critical behavioral outcome of digital capability.

Previous research consistently demonstrates that greater technology acceptance increases individuals' participation in digital entrepreneurship, online financial services, and digital communication, thereby enhancing economic productivity and social engagement (Anagreh et al., 2024; Li et al., 2023; Mishra, Kandpal, et al., 2024; Sindakis & Showkat, 2024). However, evidence concerning coastal women remains limited, even though this group experiences unique geographical and infrastructural constraints that may influence digital technology adoption. Based on TAM, DOI Theory, and previous empirical evidence, this study proposes that stronger technology acceptance enables coastal women to utilize digital technologies more effectively, thereby reinforcing their empowerment.

H5. *Technology acceptance positively influences women empowerment.*

2.4 Mediating and Moderating Mechanisms

The relationship between digital literacy and sustainable development is unlikely to occur directly without behavioral and social mechanisms that facilitate the transformation of digital capabilities into tangible development outcomes. The Capability Approach emphasizes that resources generate meaningful outcomes only when individuals possess sufficient agency to convert available capabilities into valuable achievements (Molla, 2021; Oades et al., 2021; Vecchio & Martens, 2021). In this regard, women empowerment is expected to serve as an important mechanism through which digital literacy enhances sustainable development among coastal women.

Previous studies consistently demonstrate that digital literacy strengthens women's empowerment by improving access to information, expanding economic opportunities, and increasing participation in community decision-making. Empowered women subsequently contribute to household welfare, community resilience, and sustainable livelihood practices (Hasmin et al., 2026; Roy et al., 2024; Susilowati & Mafruhah, 2023). Therefore, women empowerment is expected to mediate the relationship between digital literacy and sustainable development.

H6. *Women empowerment mediates the relationship between digital literacy and sustainable development.*

Furthermore, Technology Acceptance Model (TAM) explains that digital competencies alone do not automatically result in technology utilization unless individuals perceive digital technologies as useful and easy to use (Antonietti et al., 2022; Martín-García et al., 2022). Previous empirical studies indicate that technology acceptance facilitates the translation of digital literacy into greater socio-economic participation and empowerment (Asad & Nazir, 2025; Djatmiko et al., 2025b; Rahman & Hossain, 2025). Accordingly, technology acceptance is proposed as a behavioral mechanism linking digital literacy and women's empowerment.

H7. *Technology acceptance mediates the relationship between digital literacy and women empowerment.*

Beyond the mediating mechanisms, community characteristics may also influence the effectiveness of women's empowerment in promoting sustainable development. Social Capital Theory suggests that networks, trust, and reciprocal relationships facilitate collaboration, knowledge sharing, and collective action within communities. Women embedded in stronger social networks are generally better able to utilize digital knowledge, collaborate in economic activities, and participate in sustainable resource management (Salamzadeh et al., 2025; Shahzad et al., 2025). Consequently, social capital is expected to strengthen the positive influence of women's empowerment on sustainable development.

H8. *Social capital positively moderates the relationship between women empowerment and sustainable development.*

2.5 Conceptual Research Model

Figure 3 illustrates the proposed conceptual framework. Drawing upon the Capability Approach, digital literacy is positioned as the primary capability that influences women empowerment, technology acceptance, and sustainable development. Women empowerment and technology acceptance function as mediating mechanisms, while social capital strengthens the influence of women's empowerment on sustainable development. The framework integrates individual capabilities, technology adoption behavior, and community resources into a unified model explaining sustainable development among coastal women.

3. Methods

3.1 Research Design

This study employed a quantitative research design using Partial Least Squares Structural Equation Modeling (PLS-SEM) to examine the relationships among digital literacy, women's empowerment, technology acceptance, social capital, and sustainable development. PLS-SEM was selected because it is appropriate for analyzing complex structural relationships involving multiple latent constructs, mediating effects, and moderating effects simultaneously. In addition, PLS-SEM provides robust parameter estimation without requiring multivariate normality and is suitable for predictive research models emphasizing theory development (Hair et al., 2022). The proposed structural model consists of five latent variables: digital literacy as the exogenous construct; women's empowerment, technology acceptance, and social capital as intervening constructs; and sustainable development as the endogenous construct. The conceptual framework was developed based on the Capability Approach, Empowerment Theory, Technology Acceptance Model (TAM), and Social Capital Theory.

3.2 Research Procedure

The research was conducted through several sequential stages. The study began with identifying research problems concerning digital literacy and sustainable development among coastal women in Tangerang Regency. This was followed by an extensive review of previous literature to establish the theoretical foundation and formulate the research hypotheses. Subsequently, a structured questionnaire was developed based on validated measurement scales adapted from previous studies. Prior to large-scale data collection, the questionnaire was reviewed to ensure clarity and content validity. After the data were collected, the measurement model and structural model were evaluated using SmartPLS 4. The final stage involved interpreting the empirical findings and drawing conclusions regarding the proposed research hypotheses.

3.3 Population and Sample

Populasi penelitian ini adalah perempuan pesisir dengan jumlah 356.273 orang. Pengambilan sampel pada penelitian ini menggunakan Probability Sampling, dengan Simple Random Sampling. The number of samples was determined using the Slovin formula dengan tingkat eror sebesar 3%, so that a research sample of 1.108 respondents was obtained. In addition to the main respondents, this study also involved

supporting informants consisting of village officials, related agencies, community leaders, coastal women's groups, and representatives of social institutions who understand the issue of empowerment and digital literacy.

3.4 Data Collection

Primary data were collected using a structured questionnaire administered through both online and offline distribution methods. Online questionnaires were distributed using Google Forms and social media platforms to improve accessibility, whereas offline surveys were conducted directly within selected coastal communities to ensure broader representation. All questionnaire items were measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Participation was voluntary, and respondents were informed about the objectives of the research prior to completing the questionnaire. To ensure confidentiality, no personally identifiable information was collected, and all responses were analyzed anonymously for research purposes only.

3.5 Data Analysis

The collected data were analyzed using SmartPLS version 4. The analysis followed the two-stage procedure recommended by Hair et al., (2019), consisting of measurement model evaluation and structural model evaluation. The measurement model was assessed through indicator reliability, internal consistency reliability, convergent validity, and discriminant validity. Indicator reliability was evaluated using outer loadings (> 0.70), while internal consistency was assessed using Cronbach's Alpha and Composite Reliability (CR), both expected to exceed 0.70. Convergent validity was evaluated using the Average Variance Extracted (AVE), with a threshold value greater than 0.50. Discriminant validity was examined using the Heterotrait Monotrait Ratio (HTMT).

The structural model evaluation included collinearity assessment, coefficient of determination (R^2), effect size (f^2), and hypothesis testing. The significance of the proposed hypotheses, including direct, mediating, and moderating effects, was examined using the bootstrapping procedure with 5,000 subsamples. Hypotheses were considered statistically supported when the t-value exceeded 1.96 and the p-value was below 0.05.

4. Results

4.1 Respondent Demographics

Table 1
Characteristics of Identity of Respondents of the Coastal Women's Community and Community of Tangerang Regency

No	Respondent Characteristics	Category	Frequency (n)	Percentage (%)
1	**Age**	15–21 Year	76	6,9
		22–29 Year	218	19,7
		30–36 Year	296	26,7
		37–43 Year	237	21,4
		44–50 Year	163	14,7
		51–57 Year	82	7,4
		58–64 Year	36	3,2
		Total	**1.108**	**100,0**
2	**Marital Status**	Unmarried	172	15,5
		Married	833	75,2
		Divorce/Widow	103	9,3
		Total	**1.108**	**100,0**
3	**Final Education**	Primary School	214	19,3
		Junior High School	286	25,8
		Senior High School	437	39,5
		Diploma (D3/D4)	63	5,7
		Bachelor (S1)	94	8,5
		Postgraduate (S2/S3)	14	1,2
		Total	**1.108**	**100,0**
4	**Main Occupations**	Housewives	451	40,7
		Work (Formal/Informal)	194	17,5
		Fisherman/Marine Product Processor	118	10,6
		Entrepreneurship/Venture	223	20,1
		Not Working	122	11,0

Source: Researcher's Results 2026

No	Respondent Characteristics	Category	Frequency (n)	Percentage (%)
		Total	**1.108**	**100,0**
5	**Ownership of Cellphones/Gadgets**	Ya	962	86,8
		No	146	13,2
		Total	**1.108**	**100,0**
6	**Long Owned Cellphone/Gadget**	< 1 Year	108	9,7
		1–3 Year	294	26,5
		> 3 Year	560	50,5
		Not Have a Phone	146	13,2
		Total	**1.108**	**100,0**
7	**Domicile Region**	Pakuhaji	221	20,0
		Kronjo	164	14,8
		Mauk	198	17,9
		Sukadiri	143	12,9
		Teluknaga	176	15,9
		Kosambi	124	11,2
		Kemiri	82	7,3
		Total	**1.108**	**100,0**
8	**Participation in Women's Communities/Communities**	Active in the community	684	61,7
		Inactive in the community	424	38,3
		Total	1.108	100,0
9	**Intensity of Internet Access**	Every day	624	56,3
		Several times a week	238	21,5
		Rarely use	100	9,0
		Not using	146	13,2
		Total	**1.108**	**100,0**

Source: Researcher's Results 2026

Based on Table 1, this study involved 1,108 respondents who were coastal women and communities in Tangerang Regency. Based on age, the majority of respondents were in the range of 30–36 years as many as 296 people (26.7%), followed by 37–43 years old as many as 237 people (21.4%) and 22–29 years as many as 218 people (19.7%), which shows the dominance of respondents in productive age. From marital status, most of the respondents were married as many as 833 people (75.2%), while 15.5% were unmarried and 9.3% were divorced/widowed. Based on the latest education, the majority are high school graduates (39.5%), followed by junior high school (25.8%) and elementary school (19.3%), while college graduates amounted to 15.4%.

Judging from work, respondents were dominated by housewives as many as 451 people (40.7%), followed by entrepreneurs (20.1%), formal/informal workers (17.5%), fishermen or seafood processors (10.6%), and unemployed (11.0%). This shows that coastal women not only play a role in households, but also are active in economic activities. A total of 962 respondents (86.8%) already owned a cellphone/gadget, with the majority having used it for more than three years (50.5%). In addition, 61.7% of respondents are active in the women's community or society, while 56.3% access the internet daily. This condition shows that most of the respondents already have access to digital technology and are quite active in the social life of the community.

Overall, the characteristics of the respondents were dominated by women of productive age, married, well educated, working as housewives and business actors, having access to digital technology, and active in the community, so that they were considered representative to describe the conditions of the community and coastal women's community of Tangerang Regency in accordance with the purpose of the research.

4.2 Visualization of Structural Models

Based on Fig. 5, the results of the outer model evaluation show that all constructs have met the criteria of convergent validity because the majority of indicators have an outer loading value above 0.70. In the Digital Literacy variable, the outer loading value ranged from 0.959–0.970, with the highest indicator DL1.1 ("I am able to use digital devices such as connecting my device to the internet, downloading files, uploading files, and storing digital data") of 0.968, while the lowest indicator DL4.4 ("Digital culture participation: sharing information on traditional and contemporary culture through digital media") was 0.957. In the Technology Acceptance Model (TAM) variable, the outer loading value is in the range of 0.927–0.943, with the highest indicators TAM1.2 ("Job performance"), and TAM4.3 ("Recommended use") of 0.943 and the lowest indicator TAM1.1 ("Productivity and work efficiency") of 0.937.

Furthermore, in the Women Empowerment variable, the outer loading value ranged from 0.719–0.936, with the highest indicator WE5.1 ("I feel an increase in welfare after being involved in economic activities") of 0.936, while the lowest indicator WE1.1 ("I have access to the business information I need") was 0.719. In the Social Capital variable, the outer loading value is in the range of 0.667–0.822, where the highest indicator is SC2.2 ("I gain useful relationships for economic and social activities") of 0.822, while the lowest indicator is SC1.1 ("I trust community members in social and economic

activities") of 0.667. Meanwhile, in the Sustainable Development variable, the value of outer loading ranged from 0.699–0.931, with the highest indicator SD3.2 ("I have easier access to health services") of 0.931, while the lowest indicator of SD1.1 ("My income has increased compared to before") was 0.667. Although there are several indicators with values below 0.70, all indicators still meet the recommended minimum limit so that they are maintained in the research model.

The results of the internal model evaluation showed that the R^2 value for the Technology Acceptance Model was 0.486 and the Women Empowerment was 0.488, which showed that both variables were in the moderate category. Meanwhile, the Sustainable Development variable obtained an R^2 value of 0.880, which shows that 88.0% of the variation in sustainable development can be explained by Digital Literacy, Technology Acceptance Model, Women Empowerment, Social Capital, and the moderation effect in the research model. The results of the pathway test showed that Digital Literacy had a positive influence on Technology Acceptance Model (β = 0.697) and Women Empowerment (β = 0.698). Furthermore, Women Empowerment has a greater influence on Sustainable Development (β = 0.284) than the Technology Acceptance Model (β = 0.254), while the direct influence of Digital Literacy on Sustainable Development is 0.207. In addition, Women Empowerment moderated the Technology Acceptance Model -> Sustainable Development relationship by 0.120 and the Digital Literacy -> Sustainable Development relationship by 0.095. Meanwhile, Social Capital also moderates the relationship between Women Empowerment -> Sustainable Development.

4.3 Discriminant Validity Heterotrait-Monotrait Ratio Result

Table 2
Results of Discriminant Validity Test Using Heterotrait-Monotrait Rasio (HTMT)

Variabel	DL	SC	SD	TAM	WE	WE × TAM	WE × DL
Digital Literacy (DL)	-						
Social Capital (SC)	0.162	-					
Sustainable Development (SD)	0.703	0.347	-				
Technology Acceptance Model (TAM)	0.702	0.147	0.761	-			
Women Empowerment (WE)	0.707	0.186	0.768	0.767	-		
WE × Digital Literacy	0.042	0.059	0.293	0.016	0.022	-	
WE x Technology Acceptance Model (TAM)	0.012	0.062	0.319	0.011	0.017	0.812	-
Social Capital × Women Empowerment	0.147	0.159	0.424	0.173	0.161	0.353	0.431
Source: SmartPLS 4 processed products							

Based on Table 2, the results of the discriminant validity test using the Heterotrait-Monotrait Ratio (HTMT) show that all HTMT values are below the limit of 0.90, so that all constructs have met the discriminant validity criteria according to Henseler et al. (2015) and Hair et al. (2022). This shows that each construct is able to distinguish itself empirically from other constructs so that there is no overlap between variables. The highest HTMT score was found in the relationship between Women Empowerment × Digital Literacy and Women Empowerment × Technology Acceptance Model at 0.812, while the lowest value was found in the relationship between the Technology Acceptance Model and Women Empowerment × Technology Acceptance Model at 0.012. All HTMT values are still below the threshold of 0.90, so the measurement model is declared to meet the discriminatory validity and is feasible to continue in the evaluation of the structural model.

4.4 Hasil Discriminant Validity Fornell-Larcker

Table 3
Results of the Discriminant Validity Test Using the Fornell-Larcker Criteria

Variabel	Digital Literacy	Social Capital	Sustainable Development	Technology Acceptance Model	Women Empowerment
Digital Literacy	0.962				
Social Capital	0.280	0.795			
Sustainable Development	0.691	0.638	0.905		
Technology Acceptance Model	0.697	0.335	0.747	0.937	
Women Empowerment	0.698	0.304	0.746	0.756	0.912
Source: SmartPLS 4 processed products					

Based on Table 3, the results of the discriminant validity test using the Fornell-Larcker criterion show that the square root value of Average Variance Extracted (√AVE) in each construct is greater than the correlation value with other constructs. According to Fornell and Larcker (1981) and Hair et al. (2022), this condition shows that each construct has a good ability to distinguish itself from other constructs so that it meets the criteria of discriminant validity. The highest diagonal value is found in the Digital Literacy variable of 0.962, while the lowest diagonal value is found in the Social Capital variable of 0.792. However, the overall value of the diagonal is still higher than the correlation between constructs in the same row and column. Thus, it can be concluded that all variables in the research model have met the Fornell-Larcker criteria, so that the measurement model is declared valid and feasible to continue in the testing of the structural model.

4.5 Reliability and Validity Results

Table 4
Construct Reliability and Validity Test Results

Variabel	Cronbach's Alpha	Composite Reliability (ρA)	Composite Reliability (ρC)	AVE
Digital Literacy	0.995	0.995	0.995	0.926
Social Capital	0.955	1.549	0.932	0.632
Sustainable Development	0.975	0.975	0.978	0.819
Technology Acceptance Model	0.991	0.991	0.991	0.879
Women Empowerment	0.977	0.977	0.980	0.832
Source: SmartPLS 4 processed products				

Based on Table 4, the results of the reliability and validity test of the construct show that all variables have met the recommended criteria. According to Hair et al. (2022), a construct is declared reliable if it has Cronbach's Alpha and Composite Reliability values greater than 0.70, while the Average Variance Extracted (AVE) value must exceed 0.50 to meet the convergent validity.

Cronbach's Alpha values of all variables are in the range of 0.955–0.991, with the highest values in the Technology Aceeptance Model (0.991) and the lowest in Social Capital (0.955). Furthermore, the Composite Reliability (ρC) value ranges from 0.932–0.991, where Digital Literacy has the highest value (0.995) and Social Capital has the lowest value (0.995). Meanwhile, the AVE value of the entire construct is in the range of 0.632–0.926, with the highest value in Digital Literacy (0.926) and the lowest in Social Capital (0.632). Although Social Capital has the lowest AVE value, it is still above the minimum limit of 0.50, so it still meets the criteria for convergent validity. Based on these results, it can be concluded that all constructs in this study have an excellent level of reliability and convergent validity, making them suitable for structural model analysis and hypothesis testing.

4.6 Determination Coefficient Results

Table 5
Value of Determination Coefficient (R^2)

Variabel Endogen	R-Square	Kategori
Sustainable Development	0.880	Substantial
Technology Acceptance Model	0.486	Moderate
Women Empowerment	0.488	Moderate
Source: SmartPLS 4 processed products		

Based on Table 5, the results of the determination coefficient (R^2) test showed that the R^2 value in the Sustainable Development variable was 0.880, which means that 88.0% of the variation in Sustainable Development can be explained by Digital Literacy, Technology Acceptance Model, Women Empowerment, Social Capital, and interaction constructs (moderation) in the research model. Meanwhile, the remaining 12.0% was influenced by other factors outside the model, such as government policy support, household economic conditions, education level, demographic characteristics, access to digital infrastructure, community participation, and other social and environmental factors that were not analyzed in this study. According to Hair et al. (2022), these values belong to the substantive category, thus showing that the model has excellent predictive capabilities.

Furthermore, the Technology Acceptance Model variable has an R^2 value of 0.486, which indicates that 48.6% of the variation in technology acceptance is explained by Digital Literacy, while the remaining 51.4% is influenced by other factors outside the model, such as the perception of ease of use, the perception of the usefulness of technology, the experience of using technology, the quality of digital infrastructure, organizational or community support, and the characteristics of individuals who were not included in this study. This value is included in the moderate category according to Hair et al. (2022). The Women Empowerment variable obtained an R^2 value of 0.488, which means that 48.8% of the variation in women's empowerment was explained by Digital Literacy, while the remaining 51.2% was influenced by other factors, such as family support, access to education and training, economic opportunities, women's empowerment policies, social and cultural norms, and individual characteristics of women that were not included in the research model. Based on the classification of Hair et al. (2022), this value is also included in the moderate category, so that Digital Literacy has a fairly good ability to explain variations in women's empowerment.

4.7 Effect Size Results

Table 6. Effect Size Test Results (f^2)

Hubungan	f^2	Kategori
Digital Literacy -> Technology Acceptance Model	0.945	Large
Digital Literacy -> Women Empowerment	0.952	Large
Digital Literacy -> Sustainable Development	0.156	Medium
Technology Acceptance Model -> Sustainable Development	0.195	Medium
Women Empowerment -> Sustainable Development	0.247	Medium
Women Empowerment × Technology Acceptance Model -> Sustainable Development	0.045	Small
Women Empowerment × Digital Literacy -> Sustainable Development	0.026	Small
Social Capital × Women Empowerment -> Sustainable Development	0.082	Kecil
Source: SmartPLS 4 processed products		

Based on Table 6, the results of the effect size (f^2) test showed that the magnitude of the influence of each construct on endogenous variables varied. According to Cohen (1988) and Hair et al. (2022), the f^2 values of 0.02, 0.15, and 0.35 indicate the small, medium, and large categories, respectively. The results showed that Digital Literacy had a major influence on the Technology Acceptance Model ($f^2 = 0.945$) and Women Empowerment ($f^2 = 0.952$). These findings show that digital literacy is a construct that contributes the greatest in increasing technology acceptance and women's empowerment.

Furthermore, the relationship between Women Empowerment -> Sustainable Development has an f^2 value of 0.247, Technology Acceptance Model -> Sustainable Development of 0.195, and Digital Literacy -> Sustainable Development of 0.156. The three relationships are included in the medium effect category, which shows that each variable has a significant contribution in explaining Sustainable Development. Meanwhile, the moderation effect showed a relatively small size of influence, namely Women Empowerment × Digital Literacy -> Sustainable Development of 0.026, Women Empowerment × Technology Acceptance Model -> Sustainable Development of 0.045, and Social Capital × Women Empowerment -> Sustainable Development of 0.082, although in the small category, this result shows that the moderation variable still contributes additionally to improving the model's ability in explaining Sustainable Development.

4.8 Hypothesis Test Results

Table 7
Hypothesis Testing Results

Hipotesis	Relationships Between Variables	β (Original Sample)	T Statistics	P Values	Verdict
H1	Digital Literacy -> Sustainable Development	0.207	13.439	0.000	Accepted
H2	Digital Literacy -> Technology Acceptance Model	0.697	46.228	0.000	Accepted
H3	Digital Literacy -> Women Empowerment	0.698	47.784	0.000	Accepted
H4	Technology Acceptance Model -> Sustainable Development	0.254	15.027	0.000	Accepted
H5	Women Empowerment -> Sustainable Development	0.286	14.831	0.000	Accepted
H6	Social Capital × Women Empowerment -> Sustainable Development	0.115	6.111	0.000	Accepted
H7	Women Empowerment × Digital Literacy -> Sustainable Development	0.095	4.787	0.000	Accepted
H8	Women Empowerment × Technology Acceptance Model -> Sustainable Development	0.120	6.224	0.000	Accepted

Source: SmartPLS 4 processed products

Based on Table 6, the results of hypothesis testing showed that all hypotheses tested had a T-statistical value greater than 1.96 and a p-value less than 0.05, so that all relationships between variables were proven to have a positive and significant effect according to Hair et al. (2022). The largest direct influence was shown by the relationship of Digital Literacy -> Women Empowerment (β = 0.698), followed by Digital Literacy -> Technology Acceptance Model (β = 0.697). These results show that increasing digital literacy makes a very strong contribution to increasing technology acceptance and women's empowerment. Furthermore, Women Empowerment (β = 0.286), Technology Acceptance Model (β = 0.254), and Digital Literacy (β = 0.207) have also been proven to have a positive and significant effect on Sustainable Development.

In the moderation relationship, Women Empowerment × Digital Literacy -> Sustainable Development had the largest coefficient (β = 0.095), followed by Women Empowerment × Technology Acceptance Model -> Sustainable Development (β = 0.120) and Social Capital × Women Empowerment -> Sustainable Development (β = 0.115). These findings show that all moderation variables are able to strengthen the relationship between variables in the research model, although the magnitude of the influence of moderation is smaller than the direct effect.

5. Discussion

The results of the study showed that all hypotheses submitted were accepted, thus confirming that Digital Literacy, Technology Acceptance Model (TAM), and Women Empowerment have an important role in encouraging Sustainable Development for coastal women in Tangerang Regency. In addition, Women Empowerment and Social Capital have also been proven to play a role as moderation variables that strengthen the relationship between variables in the research model. These findings show that sustainable development is not only determined by the ability of individuals to utilize digital technology, but also influenced by acceptance of technology, women's capacity to take advantage of economic opportunities, and conducive social environment support.

The results of the study show that Digital Literacy has a positive and significant effect on Sustainable Development, Technology Acceptance Model, and Women Empowerment. The greatest influence was shown on the relationship between Digital Literacy -> Women Empowerment (β = 0.698), followed by Digital Literacy -> Technology Acceptance Model (β = 0.697). These findings indicate that the higher the ability of coastal women to use digital devices, access information, apply digital ethics, and maintain digital security, the higher their acceptance of technology and the stronger their capacity to participate in economic and social activities. This finding is in line with the Capability Approach put forward by Sen (1999), who explains that development is the process of expanding individual capabilities to utilize resources into valuable life choices. In the context of this research, digital literacy is an important capability that allows women to gain access to business information, digital financial services, online marketing, and various economic opportunities that were previously difficult to reach.

The findings are supported by research (Irfan & Salam, 2020), which states that digital literacy increases women's economic opportunities while contributing to the achievement of the Sustainable Development Goals (SDGs). Similar results were also found by (Kumar et al., 2024), which shows that digital literacy is able to increase technology acceptance and women's empowerment through expanding access to information, education, and digital entrepreneurial activities. On the contrary, (Winarti et al., 2025), found that digital literacy has not been able to increase women's socio-economic resilience in areas with limited digital infrastructure and low internet access. These differences show that the effectiveness of digital literacy is greatly influenced by infrastructure readiness, institutional support, and opportunities for communities to implement digital capabilities in productive activities. In the context of coastal women in Tangerang Regency, the availability of internet access, the use of smartphones, and various community empowerment programs allows digital literacy to provide more tangible benefits for sustainable development.

This study also shows that the Technology Acceptance Model has a positive effect on Sustainable Development (β = 0.254), while Women Empowerment has a greater influence (β = 0.286). These results indicate that the acceptance of technology does contribute to sustainable development through increased productivity, access to information, and efficiency of economic activities. However, the impact becomes greater when women have the ability to make decisions, access to resources, and the

confidence to utilize technology productively. These findings support the Technology Acceptance Model developed by (Davis, 1989), which explains that the perception of the convenience and usefulness of technology will encourage individuals to adopt technology in their daily activities. On the other hand, the results of this study also strengthen the view of (Andriamahery & Qamruzzaman, 2022; Njuki et al., 2023), that women's empowerment is a process of increasing access to resources, decision-making skills, and the achievement of welfare that ultimately contributes to development.

The results of this study are consistent with the findings of the (Awan & Yaqoob, 2023; Surya et al., 2021), explaining that technology adoption contributes to increased productivity and economic development, and (S. Gupta et al., 2024; Sertyesilisik, 2023) which affirms that women's empowerment is one of the main pillars in achieving sustainable development goals. Nevertheless, (Shahadat et al., 2023), explained that the acceptance of technology does not always result in development if it is not supported by the capacity of human resources and institutional readiness. Meanwhile, (Ahmed & Hyndman-Rizk, 2020; Manhas, 2025), It also emphasized that increasing women's capacity does not necessarily result in development if women still face structural obstacles in the form of inequality of access to education, employment, and economic resources. Therefore, the success of sustainable development requires a combination of improving digital capabilities, adopting technology, and strengthening women's capacity in a sustainable manner.

In addition to direct influence, this study proves that Women Empowerment plays a role as a moderation variable that strengthens the relationship between Digital Literacy and Sustainable Development and the relationship between the Technology Acceptance Model and Sustainable Development. These results show that the benefits of digital literacy and technology acceptance will be greater if women have the ability to manage resources, make decisions, and take advantage of available economic opportunities. On the other hand, Social Capital has also been shown to strengthen the relationship between Women Empowerment and Sustainable Development, albeit with a relatively small effect size. These findings show that trust, social networks, community support, and social norms continue to contribute to increasing the effectiveness of women's empowerment towards sustainable development. These results are in line with (Sabet & Khaksar, 2024) which emphasizes that social capital is able to increase the collective capacity of the community through cooperation and trust, and is supported by (Moghfeli et al., 2023) which shows that social networks play an important role in increasing community resilience and the success of community-based development. On the contrary, (Baycan & Öner, 2023; Straub et al., 2020), reminding that social capital does not always have a positive impact if social relations are exclusive and limit access to development resources by other groups.

6. Conclusion

This study proves that Digital Literacy is the main factor that encourages the achievement of Sustainable Development for coastal women in Tangerang Regency. The results of the study show that digital literacy has a positive and significant effect on the Technology Acceptance Model (TAM), Women Empowerment, and Sustainable Development. Among all direct relationships, the greatest influence was

shown by the relationship between Digital Literacy and the Technology Acceptance Model, which indicated that improving digital competence was able to increase coastal women's acceptance of technology. In addition, Women Empowerment has a greater influence on Sustainable Development than the Technology Acceptance Model, showing that sustainable development does not only depend on the use of technology, but also on women's ability to access resources, make decisions, and participate in economic and social activities.

This research also proves that Women Empowerment strengthens the influence of Digital Literacy and Technology Acceptance Model on Sustainable Development, while Social Capital strengthens the relationship between Women Empowerment and Sustainable Development. The findings show that the success of digital transformation in coastal areas requires a combination of increasing digital literacy, technology acceptance, women's empowerment, and social capital support. Thus, this study confirms that sustainable development in coastal communities cannot be achieved only through the provision of technology, but also through strengthening individual capacity and the social environment that supports the productive and sustainable use of technology.

7. Practical implications

The results of this study provide several practical implications for governments, community organizations, and other stakeholders. First, local governments need to expand digital literacy programs that not only focus on technical skills using technology, but also include digital entrepreneurship training, digital marketing, digital security, and the use of digital financial services for coastal women. Second, improving digital infrastructure, such as equitable and affordable internet access in coastal areas, is an important prerequisite for reducing the digital divide. Third, women's empowerment programs need to be directed at increasing leadership capacity, decision-making skills, access to economic resources, and strengthening women's business networks. In addition, the strengthening of social capital through women's groups, cooperatives, coastal communities, and local organizations needs to be encouraged in order to increase collaboration, knowledge exchange, and the successful implementation of digital-based sustainable development programs.

8. Theoretical implications

This research contributes to the development of the literature by integrating Capability Approach, Technology Acceptance Model (TAM), Empowerment Theory, and Social Capital Theory into a single conceptual framework to explain sustainable development in coastal women. In contrast to previous research which generally only examined the direct influence of digital literacy on empowerment or sustainable development, this study shows that the influence of digital literacy is not only direct, but also strengthened through the acceptance of technology and women's empowerment, and supported by social capital as a contextual factor. These findings expand the application of these theories to the context of coastal communities in Indonesia which are still relatively limited in empirical studies, thus

providing a new perspective on the relationship between digital capabilities, technology adoption, women's empowerment, and sustainable development.

9. Limitations and future research

This research has several limitations that need to be considered. First, the research was only conducted on coastal women in Tangerang Regency so that the results of the study could not be generalized to other coastal areas that have different social, economic, and cultural characteristics. Second, the research uses a cross-sectional approach, so it has not been able to describe changes in digital literacy, technology acceptance, and women's empowerment dynamically over time. Third, although the research model has a high predictive ability for Sustainable Development, there are still other factors outside the model that have the potential to affect sustainable development, such as government policy support, quality of digital infrastructure, education level, household economic conditions, digital financial inclusion, institutional capacity, and community environmental awareness.

Therefore, further research is recommended to use a longitudinal approach or mixed methods to be able to explain changes in digital behavior and women's empowerment more comprehensively. In addition, comparative research on various coastal areas in Indonesia and other developing countries needs to be conducted to improve the external validity of the research model. Future research can also develop conceptual models by adding variables such as digital financial inclusion, digital entrepreneurship, government support, institutional quality, innovation capability, environmental awareness, and community resilience, so as to provide a more comprehensive understanding of the factors that affect sustainable development in coastal communities.

Declarations

Ethics approval and consent to participate

The study was reviewed by the Institutional Review Board of the University of Muhammadiyah Tangerang, Indonesia, which determined that it involved minimal risk to participants and therefore granted a waiver of the requirement for formal ethical approval. All research procedures were conducted in accordance with the ethical guidelines and regulations of the University of Muhammadiyah Tangerang Institutional Review Board and adhered to the principles outlined in the Declaration of Helsinki. All participants gave their informed consent to participate in the study before being able to fill in the questionnaire.

Consent for publication

Note applicable.

Competing interests

The authors report that there are no competing interests to declare

Funding

This research was supported by the National Competitive Research Grant 2026, under the Fundamental Research Regular scheme, provided by the Ministry of Higher Education, Science, and Technology (Kemdiktisaintek) through the Directorate of Research and Community Service, Directorate General of Research and Development, Republic of Indonesia. The authors gratefully acknowledge this crucial support, which enabled the successful completion of this study.

Author Contribution

T.A., A.G., K.E., and S.A are jointly responsible for the conceptualisation, data collection, writing and editing of the final report T.A., and S.K are responsible for revising key section, re-analysis of data, editing of final revised mansucript.

Data availability

All data are included in the manuscript. No new data was generated for the research described in the article.

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Figures

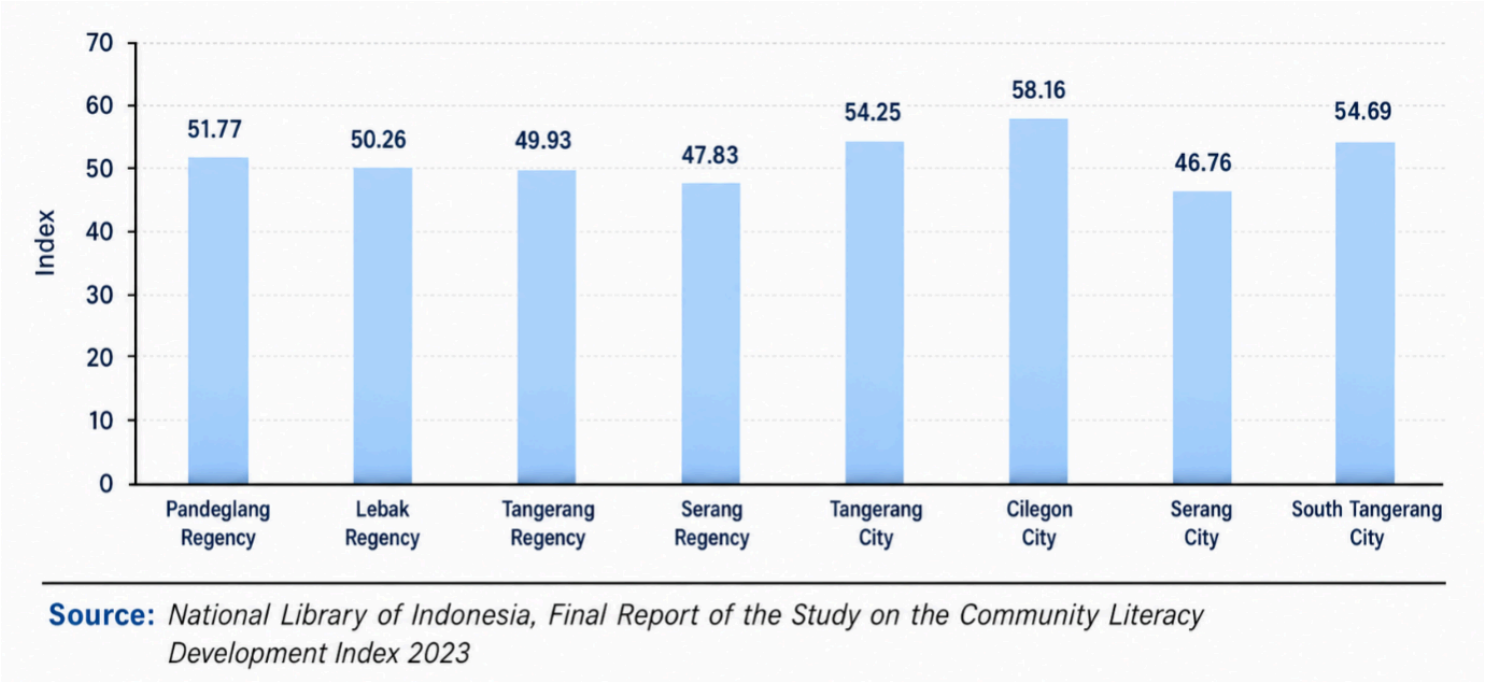


Figure 1

Community Literacy Development Index by Regency/City in Banten Province, 2023

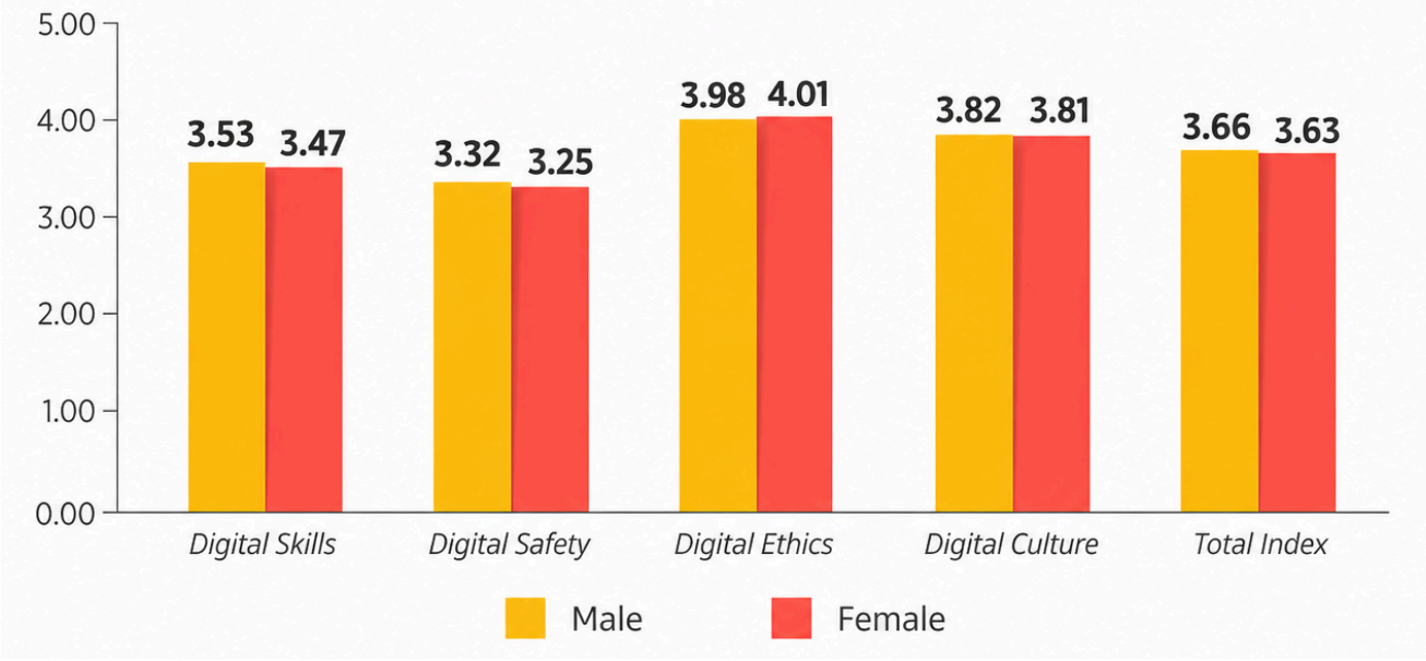


Figure 2

Indonesia's digital literacy index by gender in 2023. Source (Kominfo, 2023)

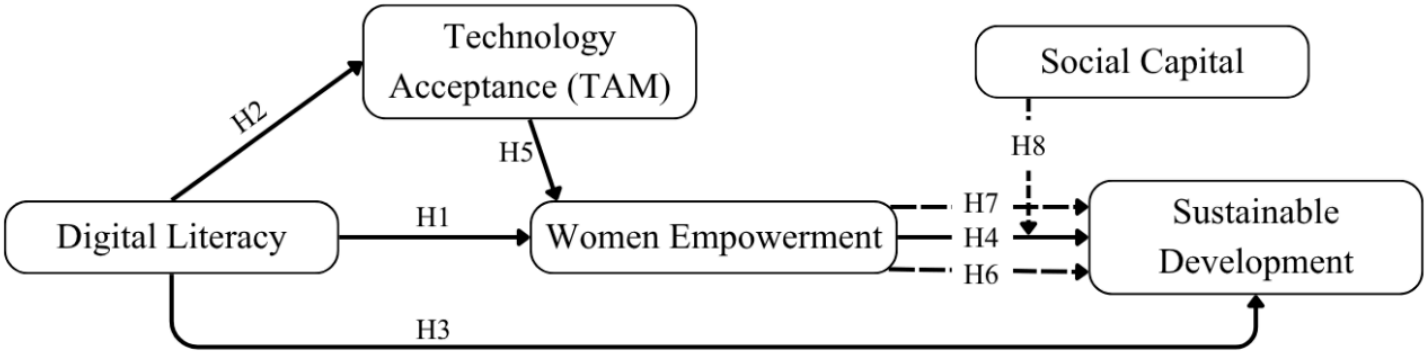


Figure 3

Conceptual Research Model

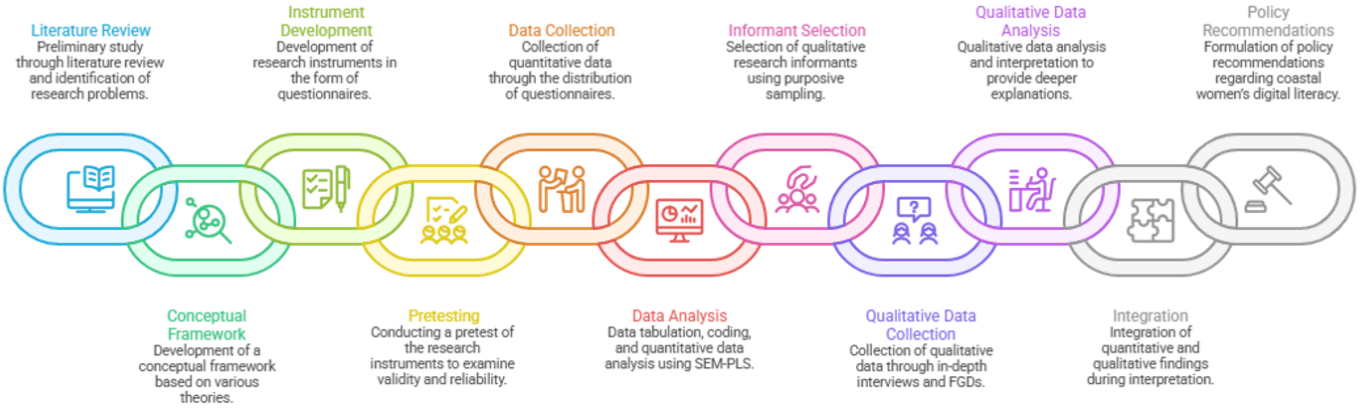


Figure 4

Research Procedure

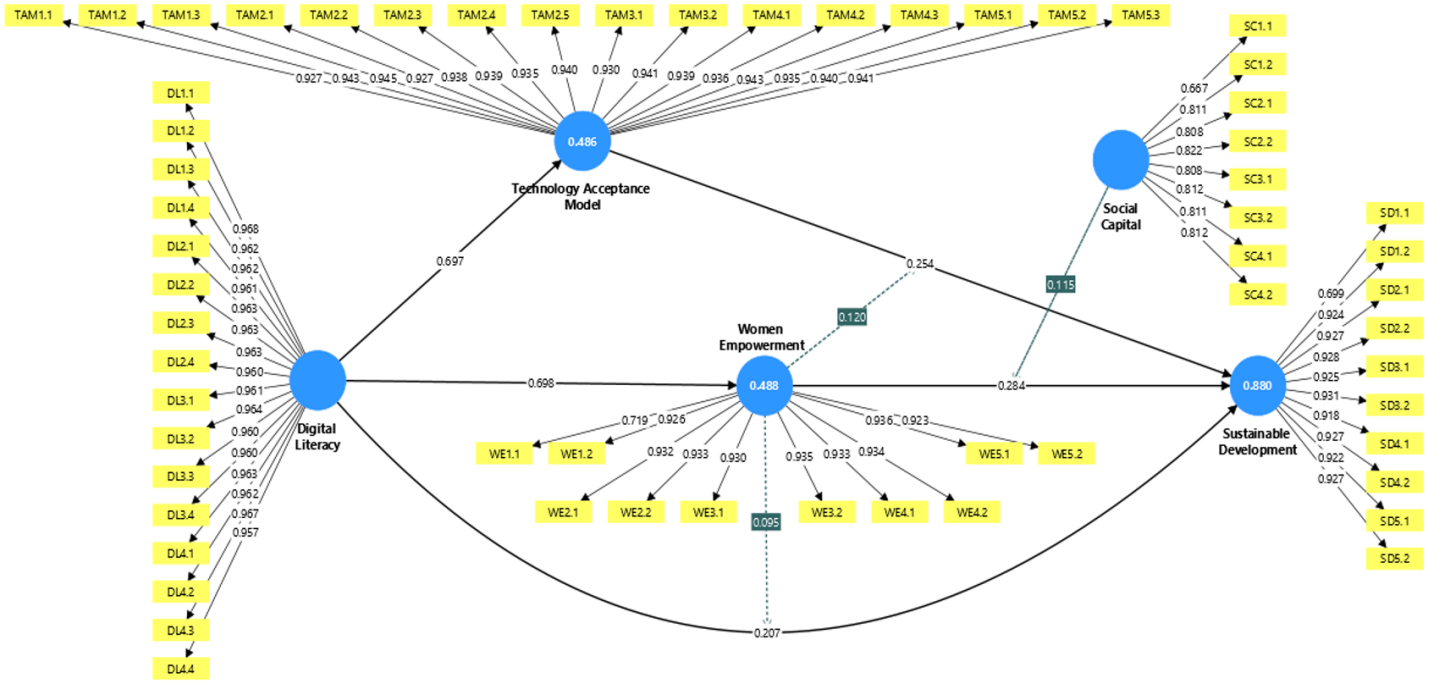


Figure 5

Results of the PLS-SEM Measurement and Structural Model, Source: SmartPLS 4 processed products