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Transformative Policy Model for Digitalising Education: Accelerating Education for Sustainable Development (ESD) in Indonesia

Rusdinal, Sulastri, Syahril
Departement of Educational Administration,
Universitas Negeri Padang, Padang, Indonesia

Rizky Amelia
Departement of Primary Education,
Universitas Lambung Mangkurat, Indonesia

Mufarrihul Hazim, Muhammad Turhan Yani, Syunu Trihanto and Hendri Budi Utama
Departement of Educational Administration,
Universitas Negeri Surabaya, Surabaya, Indonesia

Abstract. Education is a cornerstone for preparing future generations to navigate change and address emerging global challenges. Within this framework, ESD stands out as a transformative paradigm that fosters awareness, engagement and accountability in addressing sustainability issues. This study aimed to develop a transformative policy model for digitalising education to accelerate the realisation of ESD in Indonesia. Employing a policy research approach, the study examined the formulation, implementation and evaluation of digital education policies. The research involved junior high school teachers and principals across 12 regencies and cities in West Sumatra. The data collection techniques in this study were questionnaires; observations and documentation analysis. Data was analysed using descriptive statistical testing and the Structural Equation Model-Partial Least Square (SEM-PLS) technique to evaluate quantitative survey results. The findings revealed a strong and significant relationship between the variables of communication and organisational structure on policy implementation, both directly and through mediating variables such as resources and disposition. This study underscored the critical role of effective communication and robust organisational frameworks in facilitating effective policy outcomes, offering actionable insights into the design of digital education policies that align with ESD principles.

Keywords: policy model; digitalising education; ESD; Indonesia

1. Introduction

Education is the main foundation of a nation's development, and in the face of current global dynamics, education plays an important role in shaping generations that can face future changes and challenges (Nousheen et al., 2020). In this context, Education for Sustainable Development [ESD] emerges as an educational paradigm that emphasises understanding, engagement and responsibility for sustainable issues (Kopnina, 2020). Along with the rapid advancement of technology, digitalisation of education (Pu R, 2022) is a solution adopted by various countries to accelerate the achievement of sustainable development goals (Li, 2022). The use of information and communication technology in the learning process promises to improve the accessibility, efficiency and quality of education (Amelia et al., 2023). However, the successful implementation of education digitalisation policies in supporting ESD still requires an in-depth understanding of the barriers, challenges and potential impacts (Riess, 2022). Indonesia as a country with a large population and diversity has complex challenges in developing an education system that is able to respond to changing times and support sustainable development goals (Purwianingsih et al., 2022). Education for Sustainable Development [ESD] is an essential foundation in producing a generation that has a deep understanding of sustainability issues and the skills to act sustainably (Kopnina, 2020; Mirza, 2015; Nousheen et al., 2020).

In an effort to achieve ESD goals, the Indonesian government faces a significant dilemma related to the digitalisation of education (Kurniawan, 2021). The government has creating various digital platforms including the independent learning platform, the education report card platform and other platforms and there is progress in the implementation of technology in schools, but major challenges still occur, such as the access gap in various regions (Alawiah & Setyorin, 2023), the lack of integration of ESD principles in the digital curriculum, and the readiness of educators to adopt this new approach (Ramadhani et al., 2024).

In 2022, there were 13 655 723 users of the independent learning platform encompassing 150 731 schools and 1 351 779 educators and educational staff who accessed the platform, with over 607 000 teaching materials downloaded (Alawiah & Setyorin, 2023; Ramadhani et al., 2024). While these numbers indicate progress, challenges such as uneven internet access in remote areas and limited availability of devices remain significant barriers. However, technological literacy issues among teachers and students reveal gaps that must be addressed promptly, especially in rural areas. Although artificial intelligence (AI) technology holds great potential for personalised learning and efficiency improvement, digital divides, ethical concerns, and data privacy issues for students are also becoming major considerations in the formulation of digital education policies (Colchester et al., 2017).

Furthermore, the policy model should prioritise the development of a digital curriculum that integrates ESD principles (Sule, 2017). In order to create a generation that understands and is committed to sustainability, learning materials

should cover global and local environmental, social and economic issues (Mifsud, 2023). Intensive and continuous training for educators needs to be implemented to ensure they can effectively transfer ESD values to students through technology (Al-Abdullatif, 2022). This approach also involves active community participation (Tungpantong et al., 2021). Communities and parents need to be empowered as partners in supporting digital-based education (Habibi, 2020). Collaboration with industry and non-governmental organisations will enrich students' learning experiences with real-world contexts, strengthen understanding of sustainability, and motivate positive action in the community (Lestiyani, 2020).

Studies have been conducted in various countries that have implemented education digitalisation policies with various approaches. However, most of these implementations have not fully integrated ESD principles into their education digitalisation policy models (Hopkins, 2019). The novelty of this research lies in its specific approach to the Indonesian context. Through a state-of-the-art analysis, this research explored policy elements that could be adopted and adapted to Indonesia's unique needs and characteristics. The novelty is also manifested in the focus on integrating ESD thoroughly in the education digitalisation policy model. The hypothesis in this study was that the communication and organisational structure variables, both directly and indirectly through the resource and disposition variables, have a positive and significant influence on the implementation of educational digitisation policies. By understanding the existing conditions, this research proposed an education digitalisation policy model that is more responsive to local challenges, creating innovative solutions to improve the sustainability of education in Indonesia.
Two research questions underpinned this study: (a) How is the implementation of education digitalisation policy accelerating ESD in Indonesia? and (b) How effective is the current evaluation model in measuring the impact of education digitalisation policies on ESD outcomes?

2. Literature Review

Digitalisation in Education: Global Trends and Challenges

Digital transformation in education has been widely studied as a means of enhancing learning accessibility, personalisation and efficiency. The global shift toward digital education has been driven by advances in AI, big data analytics and cloud computing (Abdulrahim & Mabrouk, 2020; Mittal et al., 2024; Ronzhina et al., 2021). These technologies facilitate adaptive learning, automated assessment and real-time data analytics for improved educational outcomes. However, several challenges persist, including the digital divide, which exacerbates educational inequities, and cybersecurity risks that threaten data privacy (Amelia et al., 2023; Aripradono et al., 2024).

In developing countries like Indonesia, digital education initiatives have encountered barriers such as inadequate internet infrastructure, uneven teacher preparedness and financial constraints. The COVID-19 pandemic further underscored the urgent need for digital education policies, revealing disparities in access to technology and digital literacy (Bilyalova et al., 2019; Pugacheva et al., 2020; Williamson, 2017). Efforts to close these gaps require government

intervention, private sector collaboration and international partnerships to create a more resilient and inclusive digital education ecosystem.

Transformative Policy Models for Digital Education

Transformative policy models emphasise systemic reforms that integrate digital tools into curriculum development, pedagogy and assessment strategies. Effective policy frameworks require comprehensive regulatory structures to ensure accessibility, data protection and content quality. This includes a structured discussion on policy formulation, stakeholder engagement and evaluation mechanisms. These enhancements ensure greater clarity and methodological rigour in presenting the research approach. Infrastructure investment is necessary to expand internet connectivity and provide essential digital devices, particularly in underserved regions (Bakir & Gunduz, 2020; Jarvis & He, 2020). Additionally, capacity-building initiatives are crucial in enhancing digital skills among educators and students through professional development programmes. Equitable access to digital education must also be prioritised to prevent marginalised communities from being left behind in the transition (Aripradono et al., 2024)

In Indonesia, the independent learning initiative represents a shift towards a more flexible and digital-friendly education system. However, researchers argue that a more comprehensive policy framework is needed to integrate digitalisation with sustainable education goals (Aripradono et al., 2024; Madani, 2019; Williamson, 2017). There is a growing need for a collaborative approach that involves stakeholders from the government, private sector and non-governmental organisations to develop a sustainable digital education model that benefits all learners.

ESD and Digitalisation

ESD aims to equip learners with the competencies needed to address sustainability challenges such as climate change, inequality, and responsible resource management (Brandt et al., 2022; Mckeown, 2014; Verhelst et al., 2021). Digital technologies can enhance ESD by facilitating access to sustainability education through online platforms that provide interactive learning resources, virtual labs, and open-access courses . Innovative learning approaches, such as gamification, virtual reality and AI-driven simulations, offer immersive learning experiences that help students better understand complex environmental issues (Kopnina, 2014b; Sinakou et al., 2019). Additionally, digital platforms foster global collaboration, enabling students and educators worldwide to exchange knowledge and work together on sustainability challenges.

In Indonesia, studies suggest that digital education can bridge gaps in sustainability education by increasing awareness and engagement among students (Verhelst et al., 2021). However, successful implementation requires local adaptation, government support and integration with national education strategies. The integration of digital technology into ESD must consider cultural, economic and social factors to ensure that sustainability education is accessible, relevant and impactful.

Despite the extensive literature on digital education and ESD, several gaps remain. There is a lack of long-term studies analysing how digital education policies influence sustainability outcomes in Indonesia. More research is needed to develop localised digital education models that align with Indonesia's diverse socio-economic and geographic conditions. Additionally, there is a need to examine the readiness of educators and students in adopting digital tools for ESD, as well as the effectiveness of various digital learning approaches in fostering sustainability awareness and action.

3. Method

This research adopted a comprehensive policy research approach, which serves to critically analyse and examine the actions and decisions made by the government within a particular policy domain (Becker et al., 2012). Policy research primarily focuses on understanding the motivations behind governmental actions – investigating why certain policies are implemented while others are not and exploring the rationale behind these decisions (Becker et al., 2012). It delved into the mechanisms through which policies are formulated and executed, assessing the various processes involved, such as stakeholder consultations, political negotiations and institutional frameworks. Additionally, the research sought to identify the beneficiaries of these policies, highlighting both the intended and unintended recipients of policy outcomes, and evaluating the broader implications for different social, economic and political groups.

Furthermore, this research assessed the direct and indirect consequences of governmental actions, examining the immediate and long-term impacts on the target population as well as on the wider societal landscape. By analysing the results of these policies, the research aimed to shed light on the effectiveness of the government's approach in addressing key issues, as well as its alignment with the initial goals and objectives set forth. In terms of methodology, this research adopted a mixed-method approach, combining both qualitative and quantitative techniques. The qualitative component involved in-depth interviews, case studies and content analysis to gain nuanced insights into the policy formulation and implementation processes. On the other hand, the quantitative aspect leveraged statistical tools and surveys to measure the impact of the policies and to assess the generalisability of the findings, ensuring a well-rounded, evidence-based understanding of the policy landscape. This dual-method strategy enables a more robust and comprehensive exploration of governmental actions, allowing for both detailed qualitative assessments and broader quantitative analyses.

A. Participants

The research subjects in this research were 300 teachers and principals of junior high schools in West Sumatra from 12 regencies/cities, namely: Padang City, Solok City, Padang Panjang City, Bukittinggi City, Payakumbuh City, Sawah Lunto City, Pariaman City, Solok Regency, Pesisir Selatan Regency, Agam Regency, Lima Puluh Kota Regency and Mentawai Islands Regency. West Sumatra was selected as the research location due to its unique socio-cultural, educational and policy landscape, which provides a compelling case for studying the digitalisation of education and its role in accelerating ESD. First, West Sumatra has a strong educational tradition, with its deep-rooted Minangkabau culture

valuing education as a crucial element of social mobility. The province is home to several leading universities, including Padang State University and Andalas University, which play a key role in research and policy discussions on education and sustainable development. Second, West Sumatra has been actively involved in digital education initiatives. The provincial government has implemented various programmes to integrate digital learning tools into schools, making it an ideal case study for examining the effectiveness of digital education policies. Third, West Sumatra's commitment to sustainability aligns well with ESD objectives. The region has a strong environmental awareness, as reflected in its policies on disaster risk reduction, conservation and sustainable economic practices. Given that ESD aims to equip learners with the knowledge and skills needed for sustainable development, West Sumatra presents a relevant context for analysing how digital education can enhance these efforts.

Table 1. Research Sample Research Host

No.	District	Number of Schools	Teacher's Experience		Number of Respondents
			± 1 - 5 years	± 6 - 12 years	
1	Padang City	8	20	25	45
2	Solok City	5	12	8	20
3	Padang Panjang City	6	14	6	20
4	Bukittinggi City	5	17	13	30
5	Payakumbuh City	4	9	11	20
6	Sawahlunto City	6	11	14	25
7	Pariaman City	6	2	5	7
8	Solok District	8	15	15	30
9	South Coastal District	12	13	22	35
10	Agam Regency	6	8	17	25
11	Lima Puluh Kota Regency	5	13	10	23
12	Mentawai Regency	6	7	13	20
	Total	77	141	159	**300**

B. Data Collection

The study employed a mixed-methods approach, integrating both qualitative and quantitative data collection techniques to provide a comprehensive and well-rounded analysis. These methodologies complemented each other, ensuring that both numerical data and in-depth contextual insights were captured. The questionnaire technique was used to gather structured quantitative data from respondents, allowing for statistical analysis of key variables. It provided measurable insights into patterns, trends and relationships within the study. To ensure the reliability and validity of the instrument, it was developed based on established theoretical constructs and tested in a pilot study before full implementation. Meanwhile, the observation technique played a crucial role in capturing real-time behaviours, interactions and environmental conditions. Observations were systematically recorded to ensure consistency and reliability in data collection. The documentation technique involved the collection and analysis of existing records, policies and official documents relevant to digital education and ESD. This secondary data helped contextualise the findings within broader policy frameworks and historical developments, strengthening the study's foundation.

The research instrument was developed based on the constructs of the variables measured, and tested in the field to obtain the validity and reliability of the instrument. The reliability estimation formula used Cronbach's Alpha, inter-rater and combined linear reliability, while the validity of the instrument was analysed by factor analysis.

C. Data Analysis

Data analysis was carried out quantitatively and qualitatively. Quantitative data analysis was carried out by descriptive statistical testing and after calculating the results of the quantitative data processing questionnaire obtained, then the incoming data were analysed and tested using the multivariate *Structural Equation Model - Partial Least Square (SEM-PLS)* technique. PLS-SEM is more flexible in handling small to medium sample sizes and non-normal data, making it ideal for this study's dataset. SEM-PLS was particularly suitable for evaluating the structural relationships between communication, organisational structure, resources, disposition and policy implementation. The technique allowed for a nuanced understanding of how these variables interact and contribute to the success of digital education policies for ESD in Indonesia. The instrument validity test used the product moment correlation from Karl Person and the reliability test used the alpha formula (r_{11}). Furthermore, qualitative data was analysed descriptively by conducting five stages of activities to ensure data validity: (1) compiling interview and observation guidelines, (2) collecting data, (3) verifying interview transcripts, (4) triangulating sources and techniques, (5) collaboration between host and partner researchers to strengthen the accuracy of data interpretation.

Data analysis at this stage used SEM SmartPLS on instrument testing and research data analysis. The test was conducted on targets that had the same characteristics as the research population, with a total of 300 respondents. The analysis was conducted to test construct validity (*convergent validity*) and discriminant validity (*discriminant validity*). The validity test was carried out using the *measurement outer model* with *convergent validity. The loading factor* that was used as a standard to determine the validity of each indicator was ≥ 0.50 on the intended variable (Hair et al., 2014). Furthermore, discriminant validity was carried out to ensure that the statements on each latent variable were not confused by respondents who answer questions based on questions on other latent variables, especially in terms of the meaning of the question. Discriminant variables were fulfilled if the *Average Variance Extract* (AVE) of the average variance extracted was higher than the correlation involving the latent variable (Kock & Lynn, 2012). Reliability testing was done with SmartPLS to determine the level of *composite reliability.* The reliability criteria for each latent variable were determined from the *composite reliability* value ≥ 0.8. It can be said that the variable had high reliability; ≥ 0.6 reliability is sufficient; less than that was low reliability; and tends to be greater than Cronbach's alpha (Mohajan, 2020). Analysis of the relationship between variables was determined by referring to the original sample value and Tstatistic which was the output of SmartPLS. The significance value of the *relationship/path* was determined by testing criteria with a significance level (α) of 5% with a standard T-statistic < 1.96. At this stage, structural modelling of *e-leadership*

variables, readiness for change and innovative learning in implementing the independent learning policy was carried out.

4. Results And Discussion

The results of research analysis were to answer the second and third research questions or objectives, namely: (1) analysing the implementation of education digitalisation policy in accelerating ESD and (2) analysing the evaluation model of education digitalisation policy in accelerating education for sustainable development.

4.1 General Description of Research Variables

This research data includes policy implementation variable data and policy evaluation variable data.

Table 2. Descriptive Data of Policy Implementation and Evaluation Variables

Descriptive Statistics							
Variables	**N**	**Mean**	**Std. Deviation**	**Minimum**	**Maximum**	**Median**	**Mode**
Policy Implementation	300	171,23	29,13	67	220	175	176
Policy Evaluation	300	177,38	31,14	51	225	180	180

The description of each policy implementation and policy evaluation variable was described as follows:

a. Policy Implementation

Complete data on the summary of policy implementation variable scores can be seen in the following table.

Table 3. Policy Implementation Research Data

No.	Description	Total
1	Policy Implementation Instrument Items	44
2	Minimum Score	67
3	Maximum Score	220
6	Average (mean)	171,23
7	Median	175
8	Mode	176
9	Standard Deviation	29,13

The policy implementation data indicates a generally strong execution, with an average score of 171.23 and a mode of 176, suggesting consistency in policy adoption. However, the standard deviation of 29.13 highlights disparities, likely due to regional infrastructure gaps or institutional readiness. While most implementations perform well, the minimum score of 67 reveals challenges in certain areas. These findings suggest the need for targeted interventions to address inconsistencies and ensure equitable digital education policy implementation across Indonesia.

b. Policy Evaluation

Complete data on the summary of policy evaluation variable scores can be seen in the following table.

Table 4. Policy Evaluation Research Data

No.	Description	Total
1	Policy Evaluation Instrument Items	45
2	Minimum Score	51
3	Maximum Score	225
6	Average (mean)	177,38
7	Median	180
8	Mode	180
9	Standard Deviation	31,14

The policy evaluation data reflects a generally strong assessment, with an average score of 177.38 and a mode and median of 180, indicating consistency in evaluation results. However, the standard deviation of 31.14 suggests notable variability, likely influenced by differing regional capacities or policy effectiveness across institutions. The minimum score of 51 highlights significant gaps in certain areas, pointing to the need for further refinement and targeted improvements in policy implementation. Overall, while policy evaluation shows positive trends, addressing disparities will be crucial for ensuring a more uniform and effective digital education policy framework.

To see the level of achievement of respondents can be seen in the following table.

Table 5. Respondents' Score Achievement Level

No.	Variables	Achievement Level	Category
1	Policy Implementation	77,83%	Good enough
2	Policy Evaluation	78,83%	Good enough

Based on the table above, the level of achievement of the policy implementation score was 77,83% of the ideal score. The level of achievement of the policy evaluation score was 78,83%.

4.2 Structural Modelling

Structural modelling in this study was carried out with Partial Least Squares Structural Equation Modelling (PLS-SEM) analysis". The model in Figure 1 is a reflective structural model.

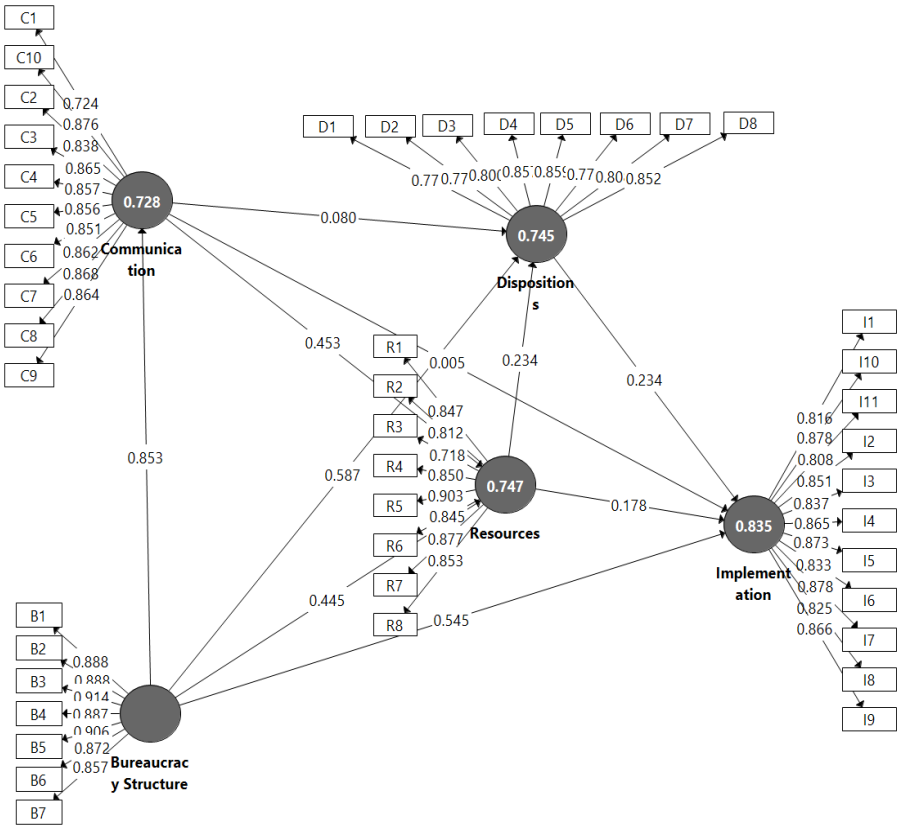

Figure 1. Structural Modelling

Data processing in this study used SmartPLS software because this research was reflective. The reflective model is a model that shows the relationship between latent variables and their indicators. This structural modeller is used to analyse data and modelling paths with latent variables. According to Ghozali and Latan (2020: 7), PLS-SEM analysis usually consists of two sub-chapter models, namely the measurement model called the outer model and the structural model called the inner model. The measurement model shows how the manifest or observed variables represent latent variables to be measured. Meanwhile, the structural model shows the strength of the estimate between latent variables or constructs.

a. *Outer analysis Loading*

In the first stage of *outer model* analysis, the *outer loading* value, *AVE* and *composite reliability* (CR) were evaluated. The results of the analysis, namely, *the loading value, average variance extracted* (AVE) and *CR*.

Average Variance Extracted **(AVE)**
Average Variance Extracted (AVE) quantifies the extent to which a latent variable or construct explains the variance of its indicators on average. It serves as a measure of convergent validity, indicating how well the observed variables represent the underlying construct. The higher the AVE value, the better a latent variable or construct is in explaining the *variance* of its indicators. An AVE value greater than 0.5 or AVE> 0.5 means that a latent variable or construct has absorbed more than 50% of the information from its indicators. The minimum limit of the AVE value is 0.5, if the AVE value> 0.5 then the latent variable or construct is acceptable (Hair et al., 2014).

Based on Table 6, all latent variables or constructs have an AVE value greater than 0.5 or AVE> 0.5, meaning that more than 50% of the *variance of* these indicators has been absorbed by their respective latent variables. In other words, latent variables or constructs were good enough in terms of representing their respective indicators. So, all latent variables or constructs can be retained in the further analysis process.

Composite Reliability **(CR)**
CR evaluates internal consistency reliability. The CR value is a more appropriate measure of reliability in SEM-PLS than Cronbach's alpha (Hair et al., 2014). Dillon-Goldstein's rho (also called *CR*) is another measure that can be used to test for unidimensionality in addition to Cronbach's alpha. Dillon-Goldstein's rho is considered better than Cronbach's alpha because the Dillon-Goldstein's rho value measure considers the extent to which the latent variable or construct explains its indicator block. A Dillon-Goldstein's rho value greater than 0.7 was considered an indicator block as unidimensional (Sanchez, 2018). The accepted CR value was the CR value greater than 0.7 or CR> 0.7. CR values between 0.6-0.7 were still acceptable in exploratory research (Hair et al., 2014). In Table 6 above, the SSS1 and SSS2 indicators were excluded from the research instrument.

Table 6. Discriminant Validity

	Bureaucracy Structure	**Communication**	**Dispositions**	**Implementation**	**Resources**
Bureaucracy Structure	0.887				
Communication	0.853	0.847			
Dispositions	0.849	0.775	0.813		
Implementation	0.896	0.800	0.841	0.849	
Resources	0.831	0.832	0.788	0.820	0.840

Furthermore, discriminant validity was determined using the AVE method for each latent variable. The criteria set for determining the AVE value was if the average variance extracted was higher than the correlation involving other latent variables. The data in Table 6 shows the AVE value of each variable against other latent variables. It can be concluded that the AVE value of each latent variable in the research has fulfilled the discriminant validity value.

Table 7. Path Coefficient

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Bureaucracy Structure -> Communication					
Bureaucracy Structure -> Dispositions	0.262	0.264	0.072	3.665	**0.000**
Bureaucracy Structure -> Implementation	0.351	0.354	0.079	4.443	**0.000**
Bureaucracy Structure -> Resources	0.387	0.391	0.074	5.243	**0.000**
Communication -> Dispositions	0.106	0.107	0.037	2.892	**0.004**
Communication -> Implementation	0.124	0.130	0.043	2.897	**0.004**
Resources -> Implementation	0.055	0.056	0.022	2.533	**0.012**
Bureaucracy Structure -> Communication -> Dispositions	0.387	0.391	0.074	5.243	**0.000**
Bureaucracy Structure -> Resources -> Dispositions	0.104	0.104	0.038	2.727	**0.007**
Communication -> Resources -> Dispositions	0.106	0.107	0.037	2.892	**0.004**
Bureaucracy Structure -> Communication -> Resources -> Dispositions	0.090	0.091	0.032	2.867	**0.004**
Bureaucracy Structure -> Communication -> Implementation	0.104	0.104	0.038	2.727	**0.007**
Bureaucracy Structure -> Dispositions -> Implementation	0.137	0.141	0.045	3.048	**0.002**
Communication -> Dispositions -> Implementation	0.055	0.056	0.022	2.533	**0.012**
Bureaucracy Structure -> Communication -> Dispositions -> Implementation	0.025	0.026	0.011	2.276	**0.023**
Bureaucracy Structure -> Resources -> Dispositions -> Implementation	0.024	0.025	0.011	2.196	**0.029**
Resources -> Dispositions -> Implementation	0.055	0.056	0.022	2.533	**0.012**
Communication -> Resources -> Dispositions -> Implementation	0.025	0.026	0.011	2.276	**0.023**
Bureaucracy Structure -> Communication -> Resources -> Dispositions -> Implementation	0.021	0.022	0.009	2.264	**0.024**
Bureaucracy Structure -> Resources -> Implementation	0.079	0.080	0.025	3.127	**0.002**
Communication -> Resources -> Implementation	0.081	0.085	0.032	2.499	**0.013**
Bureaucracy Structure -> Communication -> Resources -> Implementation	0.069	0.073	0.028	2.474	**0.014**
Bureaucracy Structure -> Communication -> Resources	0.387	0.391	0.074	5.243	**0.000**

Note = Sig. value of less than p<0.05

Based on Table 7, each relationship formed was positively and significantly related. It can be concluded that communication and organisational structure variables had a positive and significant influence on policy implementation variables directly or through resource and disposition variables. Likewise, there

was a significant direct relationship between all exogenous variables and endogenous variables in this study.

5. Discussion

Education is the foundation of a nation's progress, playing a pivotal role in shaping both its present and future. In today's fast-changing global environment, learning extends beyond the mere acquisition of knowledge; it serves as a vital tool for equipping future generations with the skills and adaptability needed to tackle complex challenges ahead. In this context, the concept of ESD emerges as a key paradigm, aligning educational practices with global sustainability goals. ESD aims not only to impart knowledge but also to develop competencies that enable students to actively contribute to sustainable development, focusing on critical areas such as environmental management, social responsibility, and economic viability (Laurie et al., 2016). Through ESD, education fosters a comprehensive approach to learning, which emphasises sustainability as a core value, thereby encouraging students to engage in both local and global initiatives that promote ecological balance, social equity and economic fairness.

The integration of ESD into educational systems promotes active participation, encouraging students to become change agents in their communities. This involves cultivating a deep sense of responsibility towards environmental stewardship, social justice and sustainable practices, thus ensuring that future generations are equipped not only with academic knowledge but also with the character and ethical grounding necessary to address pressing global challenges, including climate change, poverty, and inequality (Kopnina, 2014a, 2018). As such, the focus of education extends beyond academic excellence to encompass character development, ethical decision-making, and environmental consciousness, preparing students to be responsible citizens in a globally interconnected world.

In response to these educational needs, the rapid advancement of technology has presented both opportunities and challenges for achieving the goals of ESD. Digitalisation in education has become a transformative force, providing new avenues for delivering knowledge, enhancing access to resources, and creating personalised learning experiences (Abdulrahim & Mabrouk, 2020; Amelia et al., 2021; Ronzhina et al., 2021). Countries around the world, including Indonesia, are increasingly adopting information and communication technology (ICT) to support the realisation of the Sustainable Development Goals (SDGs). The integration of ICT in education has the potential to revolutionise teaching and learning by increasing accessibility, improving the efficiency of educational delivery, and enhancing the overall quality of education (Biagi & Loi, 2013; Naik et al., 2022). Particularly in remote or underserved regions, digital technologies such as online learning platforms can bridge educational gaps, allowing students to access high-quality resources and engage in meaningful learning experiences regardless of geographical barriers (Saddhono et al., 2019).

However, while the promise of digitalisation in education is significant, it also presents several challenges that must be addressed to ensure its successful

integration within the framework of ESD. The digital divide, which refers to disparities in access to digital technologies, remains a critical issue, particularly in developing countries like Indonesia (Amelia et al., 2023; Prasetio et al., 2021). Students in rural or poor areas often face limited access to reliable internet and modern devices, hindering their ability to fully benefit from digital educational resources (Jurriens & Tapsell, 2017; Prasetio et al., 2021; Zaman et al., 2018). Moreover, concerns related to cybersecurity, data privacy and the ethical use of technology pose additional challenges that need to be effectively managed to ensure the safety and security of students and educators alike.

Despite these challenges, the potential benefits of digital technologies in education are immense. ICT can support personalised learning experiences, allowing students to learn at their own pace, catering to diverse learning needs, and fostering a culture of lifelong learning. It can also encourage collaborative learning, where students from different cultural backgrounds and regions come together to solve global sustainability challenges (Amballoor & Naik, 2023; Greenhow et al., 2020). The development and implementation of digital learning tools have the potential to transform education by making it more inclusive, flexible and adaptive to the needs of a rapidly changing world.

Indonesia, with its large population, cultural diversity and geographical challenges, faces a unique set of circumstances in developing an education system that is both responsive to the demands of a digitalised world and aligned with the goals of ESD. The country must address complex issues such as equity in access to digital resources, the training of educators in new technologies, and the integration of sustainability principles into the curriculum (Mirza, 2015). By embracing digitalisation and aligning it with ESD, Indonesia can create a more equitable, sustainable, and resilient education system that not only meets the needs of the present but also prepares future generations to face the challenges of an uncertain and rapidly changing world (Verhelst et al., 2021).

The Indonesian government has made significant strides in addressing the challenges of digital education by launching various platforms such as independent learning platform and the education report card platform. These initiatives are designed to support the creation of robust learning communities, fostering collaboration and the exchange of best practices among educators. As highlighted by Thoriq et al. (2024), these platforms have proven effective in enabling teachers to share knowledge, resources and teaching strategies, thereby enhancing the overall quality of education across the nation. However, despite the progress in integrating technology into the education system, several barriers remain that hinder the full realisation of digital education's potential (Thoriq et al., 2024). These challenges include the persistent access gap between urban and rural regions, the insufficient incorporation of ESD principles into the digital curriculum, and the varying levels of readiness among educators to adopt and integrate these new technological tools into their teaching practices (Sinakou et al., 2019).

To effectively address these challenges, a comprehensive and multifaceted problem-solving approach is required. Firstly, a nationwide evaluation of technology infrastructure should be conducted to assess the gaps and disparities in access to digital resources. This evaluation would help identify regions that are under-equipped and require targeted investment to improve digital connectivity and infrastructure. As Putra et al. (2024) emphasise, many students in remote and rural areas continue to lack access to essential digital devices, such as computers, tablets, and reliable internet connections. This digital divide exacerbates educational inequity, preventing students in underserved areas from benefiting equally from digital learning resources. By identifying these infrastructure gaps, the government can allocate resources more effectively to ensure that all students, regardless of their geographic location, can access quality digital education.

In parallel with addressing access issues, the development of a digital curriculum that integrates ESD principles must be prioritised. ESD focuses on equipping students with the knowledge, skills, and values necessary to contribute to sustainable development, including environmental stewardship and social responsibility. To ensure the curriculum is relevant and impactful, it should reflect local environmental issues and challenges. For instance, as demonstrated by the development of educational materials in Bangka Island, which emphasised environmental literacy and local relevance, the curriculum should incorporate region-specific content that addresses the unique environmental and socio-economic issues faced by different communities. This approach not only promotes environmental awareness but also fosters a deeper connection between students and their local context, making learning more engaging and meaningful.

Furthermore, to fully integrate technology with ESD, educators must receive comprehensive training to effectively apply digital tools aligned with ESD goals. Training programmes should equip teachers with the skills to utilise emerging technologies such as AI and the Internet of Things (IoT) in ways that support sustainability education. As Amballoor and Naik (2023) argue, AI and IoT have immense potential to enhance learning by providing personalised educational experiences, enabling real-time environmental monitoring, and fostering a deeper understanding of sustainability concepts. By integrating these technologies into the teaching process, educators can offer innovative learning experiences that not only impart knowledge but also encourage students to actively engage with and address sustainability issues. This approach requires substantial investment in teacher professional development, ensuring that educators are not only familiar with the tools but also understand how to align them with ESD objectives.

In addition to the professional development of educators, it is crucial to empower communities, including parents, as active partners in supporting digital education. The participation of parents in their children's educational journey is vital, particularly in the context of digital learning. Parents can play an essential role in encouraging their children to use technology responsibly and in reinforcing the values of sustainability at home. By fostering a strong partnership between schools, parents and the broader community, digital education becomes a shared responsibility, which can lead to more successful outcomes (Mckeown,

2014; Verhelst et al., 2021). Moreover, collaboration with industry and non-governmental organisations can further enrich students' learning experiences. By working together with these external partners, schools can offer students access to real-world applications of sustainability principles, provide mentorship opportunities and organise projects that directly address local environmental or social issues. These collaborations also serve to strengthen students' understanding of the interconnectedness of various global and local challenges, motivating them to take positive action within their communities. As industries increasingly recognise the importance of sustainability, their involvement in education can help bridge the gap between theoretical learning and practical implementation, enhancing students' ability to contribute meaningfully to SDGs (Kopnina, 2014b; Sinakou et al., 2019; Verhelst et al., 2021).

In conclusion, while digital education holds significant promise for advancing sustainable development in Indonesia, overcoming the barriers of access, curriculum integration and educator preparedness requires a collaborative and comprehensive effort. By addressing these challenges, Indonesia can create a more inclusive, sustainable and effective education system that prepares students to thrive in an increasingly digital and interconnected world. Through strategic investments, curriculum reforms, professional development for educators, and community engagement, Indonesia can ensure that its educational system is not only technologically advanced but also aligned with the principles of sustainability and social responsibility.

6. Conclusion

The study's findings highlight the significant positive correlation between communication, organisational structure and policy implementation, particularly in the context of digitalising ESD in Indonesia. Effective communication ensures that policies are clearly understood and widely supported, facilitating collaboration among stakeholders such as government officials, educators and local communities. Meanwhile, a well-structured organisation provides the necessary framework for coordinating resources, decision-making and implementation strategies, ensuring that policies are executed efficiently.

Additionally, the study underscores the critical role of resources and stakeholder disposition in mediating policy implementation. Adequate funding, infrastructure and technology are essential for the success of digital education initiatives, particularly in remote areas. Furthermore, the willingness of policymakers, educators and communities to embrace digital transformation significantly impacts the adoption and sustainability of these initiatives. The research establishes a direct relationship between communication, organisational structure, resource availability and policy implementation, reinforcing the idea that a holistic approach is necessary to achieve ESD goals.

A limitation of this study is the sample size, which, while sufficient for analysis, may not fully represent all regional variations in Indonesia. Additionally, the regional specificity of the study, focusing on West Sumatra, may limit the generalisability of findings to other provinces with different socio-economic and technological infrastructures. Furthermore, researchers have suggested future

research directions, including longitudinal studies to track the long-term impact of digital education policies on ESD implementation and comparative studies across different regions to assess policy effectiveness in diverse educational and socio-cultural contexts, focus on strengthening infrastructure, improving digital literacy programmes, fostering multi-stakeholder collaboration and ensuring equitable access to technology. These additions enhance the study's transparency and provide avenues for further exploration.

The study emphasises the need for an integrated and transformative policy model to enhance digital education and accelerate ESD in Indonesia. Key recommendations include strengthening communication channels, investing in infrastructure and fostering a collaborative culture that prioritises sustainability. Importantly, digital education reform should not solely focus on technological advancements but also address human and organisational factors that influence policy execution at all levels. By adopting a coordinated approach, Indonesia can build a more inclusive, resilient and sustainable education system that prepares students with the knowledge and skills needed for the future.

7. References

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