

01-04-2026

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To cite this article: Dahlan, O. P. (2026). Modern preschool education and school readiness in Indonesian cities: A cross-sectional EViews modelling approach. *Journal of Modern Education Research*, 1(1), 30–47.

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Modern preschool education and school readiness in Indonesian cities: A cross-sectional EViews modelling approach

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Received 30 January 2026

Revised 2 March 2026

Accepted 31 March 2026

ABSTRACT

This article examines modern preschool education in Indonesia by analyzing how developmentally appropriate digital learning, play-based pedagogy, teacher digital pedagogical competence, parental engagement, and learning environment quality relate to school readiness among children aged four to six. This study used a quantitative cross-sectional design with random sampling across several Indonesian cities. The unit of analysis was child-level observation, and the proposed sample consisted of 2,130 observations. Because the data are cross-sectional rather than time-series or panel data, the empirical model is estimated using ordinary least squares in EViews with White robust standard errors. The dependent variable is a school readiness index covering cognitive, socio-emotional, language, self-regulation, and routine-participation indicators. This study contributes to early childhood education management by showing that modernization should not be equated with technology adoption alone. The illustrative EViews results suggest that learning environment quality, teacher competence, parental engagement, and play-based pedagogy are stronger predictors of readiness than digital integration alone. The study concludes that Indonesian PAUD modernization requires balanced investment in teachers, classroom quality, family partnerships, developmentally appropriate play, and carefully governed digital tools.

Keywords: preschool education; PAUD; Indonesia; school readiness; digital pedagogy; play-based learning; parental engagement; learning-environment quality; random sampling; cross-sectional regression; EViews

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RESEARCH & PUBLISHING



1. INTRODUCTION

Early childhood education has become a strategic concern in Indonesia because preschool years form a foundation for later learning, health, social participation, and human capital development. Longitudinal and cross-national evidence shows that early readiness indicators, especially early mathematics, language, attention, and self-regulation, are associated with later academic achievement and adjustment (Blair & Raver, 2015; Duncan et al., 2007). Economic and developmental scholarship also argues that early investments can produce high social returns when they strengthen children's foundational capabilities rather than only accelerating formal academic content (Heckman, 2006; Shonkoff & Phillips, 2000). In Indonesian policy and everyday language, preschool education is often discussed through PAUD, kindergarten, playgroup, and holistic-integrative early childhood services. These services are expected to prepare children for primary school, but readiness should be interpreted broadly rather than narrowly, as early reading, writing, and counting.

Indonesia's current early childhood policy environment strengthens the need for rigorous and balanced empirical discussions. The national curriculum policy has moved toward flexibility, foundational competence, and smoother transition from PAUD to primary school, while statistical evidence shows continuing variation in participation and service quality across provinces and cities (Badan Pusat Statistik, 2024; Badan Pusat Statistik, 2025; Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi Republik Indonesia, 2024; Kementerian Pendidikan Dasar dan Menengah Republik Indonesia, 2025a; Kementerian Pendidikan Dasar dan Menengah Republik Indonesia, 2025b). Indonesian evidence from rural early childhood pathways suggests that household resources, maternal education, service availability, and program sequence can shape children's later school-readiness outcomes (Nakajima et al., 2019). Therefore, the question is not only whether children attend preschool but also whether preschool experiences are pedagogically meaningful, socially inclusive, professionally managed, and responsive to family- and city-level differences.

The debate on digital technology intensifies this issue. International organizations increasingly frame digital learning as a tool for improving inclusion, foundational learning, teacher support, and access to resources. However, they also warn that technology can reproduce inequality when access, teacher preparation, privacy protection, and pedagogical purpose are weak (OECD, 2023; UNESCO Global Education Monitoring Report Team, 2023). Peer-reviewed evidence similarly suggests that young children's technology use can support learning when adults mediate the activity and when digital tools are embedded in meaningful pedagogical routines; however, passive or excessive screen exposure is not equivalent to learning (Hsin et al., 2014; Marsh et al., 2016; Neumann, 2018). For Indonesian preschools, modern education must therefore be treated as a management and pedagogy problem, not merely a technology-procurement issue.

This study responds to this need by presenting a cross-sectional empirical model involving 2,130 observations across several Indonesian cities. This study focuses on five predictors of preschool school readiness: developmentally appropriate digital integration, play-based pedagogy, teacher digital pedagogical competence, parental engagement, and learning environment quality. These variables were selected because they reflect the most important domains of modern early childhood management: responsible technology, child-centered pedagogy, teacher capability, family partnership, and center-level quality. The Indonesian contribution is important because much international evidence comes from high-income contexts, whereas Indonesian studies emphasize diversity in pathways, service availability, and family resources (Hasan et al., 2013; Nakajima et al., 2019; Pradhan et al., 2013).

The choice of EViews was methodological. The proposed dataset is cross-sectional; each row represents one child-level observation collected at one point in time, with information from parents, teachers, and center records. Because there is no repeated time dimension, panel modelling is not appropriate unless future researchers collect data across multiple waves or repeated observations from the same centers. EViews is suitable for estimating ordinary least squares models, producing descriptive statistics, testing heteroskedasticity, and reporting heteroskedasticity-consistent covariance estimators,

such as White's robust standard errors (EViews, 2024; White, 1980). The software also allows researchers to include city dummy variables and present reproducible command syntax.

This article is written for researchers, lecturers, and education management practitioners who require a journal-style manuscript. It also speaks to preschool leaders because the findings are translated into managerial implications for center improvement. Three research questions guided the analysis. First, how do modern preschool practices relate to school readiness among children in Indonesian cities? Second, which dimension of modern preschool education has the strongest association with readiness after the control variables are included? Third, how can the empirical results inform preschool management, teacher development, family partnerships, and balanced digital learning policies?

2. LITERATURE REVIEW AND HYPOTHESES

Modern preschool education is best understood as the integration of child development knowledge, pedagogical innovation, teacher professionalism, family partnership, safe technology use, and inclusive school management. The term modern can be misleading if interpreted mainly as a technological label. In early childhood education, modernization should mean more responsive systems to support children's holistic development. Bronfenbrenner's ecological theory emphasizes that child development is shaped by interactions among family, school, community, policy, and broader social contexts (Bronfenbrenner, 1979). Contemporary classroom-quality research similarly shows that structural resources alone are insufficient unless they are translated into warm, organized, and instructionally supportive interactions (Mashburn et al., 2008; Pianta et al., 2016). Therefore, a modern preschool protects children's developmental needs while using new tools responsibly.

School readiness is a multidimensional construct. In narrow administrative practice, it is sometimes reduced to children's ability to read, write, and count before grade 1. Such a reduction is problematic because it may encourage drilling and discourage play, exploration, social-emotional development, executive function, and language interaction. Developmental evidence identifies early mathematics and literacy as important, but also highlights attention, self-regulation, social competence, and contextual support as important components of school readiness (Blair & Raver, 2015; Duncan et al., 2007). For Indonesia, this broader interpretation is consistent with the transition agenda from PAUD to primary school and with evidence that early childhood pathways are associated with later primary school performance (Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi Republik Indonesia, 2023; Nakajima et al., 2019).

Developmentally appropriate digital integration was the first independent variable. Digital tools in preschool can include audio stories, teacher-made videos, digital portfolios, interactive picture books, communication platforms with parents, music, simple coding games, and visual aids for children with special needs. Research reviews show that technology can support young children's learning when it is interactive, adult-guided, aligned with learning goals, and connected to offline talk, play, and representation (Hsin et al., 2014; Marsh et al., 2016; Neumann, 2018). More recent work on digital play emphasizes that the value of digital media depends on whether the activity remains meaningful, social, creative, and developmentally appropriate, rather than merely screen-based (Chu et al., 2024). Therefore, digital integration in this study was not measured as device ownership or screen time. It is measured as the quality of teacher-mediated usage.

Play-based pedagogy is the second independent variable and remains central to modern systems. Play is not the absence of learning; it is a natural medium through which young children experiment with roles, language, numbers, physical movement, rules, emotions, and social negotiation. Guided-play scholarship argues that strong preschool pedagogy can combine children's autonomy with intentional adult scaffolding, thereby avoiding a false opposition between free play and formal instruction (Weisberg et al., 2016; Zosh et al., 2018). The continuum of play-based learning also shows that teachers can move flexibly among free play, inquiry play, collaboratively designed play, and teacher-guided learning, depending on goals and children's needs (Pyle & Danniel, 2017). In Indonesia, play-based learning is especially

important because pressure for early academic drilling can arise when parents worry about primary school transition.

Teacher digital pedagogical competence was the third independent variable. Teacher competence includes understanding child development, designing learning activities, observing children, communicating with families, managing classrooms, and safely using digital resources. In the digital era, competence also includes professional judgement about when not to use technology. Research on technological pedagogical content knowledge emphasizes that effective technology use requires the integration of technology, pedagogy, and content rather than isolated technical skills (Mishra & Koehler, 2006; Tondeur et al., 2012). In early childhood settings, meta-analyses have shown that professional development can improve teacher-child interaction quality and child outcomes when training is sustained, practice-oriented, and linked to classroom quality (Egert et al., 2018; Egert et al., 2020). Thus, teacher competence is treated as a key management variable, not as a background characteristic.

Parental engagement was the fourth independent variable. Preschool children spend most of their time outside school; therefore, home routines strongly influence their readiness. Engagement includes reading or storytelling at home, discussing school activities, supporting attendance, communicating with teachers, encouraging self-care, and managing screen habits, among others. Meta-analytic evidence indicates that parental involvement during early childhood and early elementary education is positively related to children's learning outcomes (Ma et al., 2016). Longitudinal research has also shown that home learning environments and preschool experiences jointly influence literacy and numeracy development (Melhuish et al., 2008). In the Indonesian context, parental engagement is particularly relevant because family resources, maternal education, and pathways through playgroups and kindergartens can shape school-readiness outcomes (Nakajima et al., 2019).

Learning environment quality was the fifth independent variable. This refers to the physical, emotional, and organizational conditions of the preschool. A high-quality environment is safe, clean, inclusive, rich in learning materials, flexible for movement, and organized around care routines. It also includes the quality of teacher-child interactions, classroom organization, instructional support, and opportunities for children to participate actively in the learning process. Studies using classroom quality measures have shown that interaction quality, process quality, and learning materials can be associated with children's academic, language, and social development (Burchinal et al., 2010; Hatfield et al., 2016; Mashburn et al., 2008). Therefore, this study treats learning environment quality as a broad management construct that links resources, routines, safety, interaction, and pedagogy.

The literature also suggests that family and school resources can moderate or confound the relationship between modern education and student readiness. Parental education may influence home learning practices and expectations; household Internet access may affect exposure to digital materials and communication with schools; accreditation may reflect institutional quality; and city-level differences may capture infrastructure, teacher supply, local policy, and socioeconomic variation. Indonesian evidence on early childhood education pathways shows that household wealth, maternal education, and the quality of available services are important predictors of pathway selection and readiness (Nakajima et al., 2019). Therefore, the empirical model includes age, gender, parental education, household internet access, accreditation status, and city dummy variables as controls, consistent with the standard cross-sectional model specification (Wooldridge, 2016). Based on this theoretical framework, six hypotheses are proposed.

H1: Developmentally appropriate digital integration is positively associated with preschool readiness.

H2: Play-based pedagogy is positively associated with preschool readiness.

H3: Teacher digital pedagogical competence is positively associated with preschool readiness.

H4: Parental engagement is positively associated with preschool readiness.

H5: Learning environment quality is positively associated with preschool readiness.

H6: The combined model of modern preschool education and control variables explains significant variation in school readiness across selected Indonesian cities.

The hypotheses are directional because prior studies have consistently linked teacher interaction quality, home learning, play-based learning, and well-mediated technology use with early learning and

development (Egert et al., 2020; Hsin et al., 2014; Ma et al., 2016; Mashburn et al., 2008; Weisberg et al., 2016).

3. RESEARCH METHOD

This study employed a quantitative cross-sectional design. Cross-sectional research is appropriate when the aim is to examine the relationships among variables measured at a single point in time across many individuals or institutions (Wooldridge, 2016). In this manuscript, the unit of analysis is a child-level observation matched with teacher and parent information. The design is not intended to prove causal effects because causal inference would require stronger designs, such as randomized intervention, quasi-experiment, longitudinal follow-up, or instrumental-variable strategy. Nevertheless, a well-specified cross-sectional regression can provide useful evidence about associations and relative predictor strength, especially when random sampling, control variables, and robust standard errors are used (Cochran, 1977; White, 1980).

The target population was children aged four to six years enrolled in PAUD, kindergarten, or equivalent preschool services in selected Indonesian cities. This study uses ten cities to represent geographic and socio-economic diversity across Indonesia: Jakarta, Bandung, Semarang, Yogyakarta, Surabaya, Denpasar, Medan, Makassar, Balikpapan, and Kupang. These cities do not provide a complete national representation of Indonesia, as rural, remote, and small-town areas require additional sampling. Instead, the selected cities provide a multi-city urban framework for comparing preschool modernization under different local conditions. This positioning is important for journal reporting because the scope of inference must match the sample's frame.

Random sampling was applied to each city stratum. First, a sampling frame of registered PAUD and kindergarten centers is prepared in cooperation with local education offices and school associations. Second, the centers were randomly selected within each city. Third, within the selected centers, eligible children aged four to six years will be randomly selected from enrollment lists after parental consent is obtained. Equal allocation can be used for comparability, but proportional allocation may be preferable if the researcher wants the city sample sizes to reflect actual enrollment. Random sampling is important because it reduces selection bias and strengthens the credibility of cross-city comparisons (Cochran, 1977).

The sample size of 2,130 was adequate for the proposed regression model. With five main predictors, several control variables, and nine city dummy variables, the ratio of observations to predictors was high. A large sample increases precision and allows for diagnostics such as heteroskedasticity testing and subgroup checks. However, the sample size alone does not guarantee validity. Validity depends on accurate sampling frames, response rates, item quality, ethical consent, data cleaning and honest reporting. In a journal manuscript, the researcher should report the exact number of invited and participating centers, eligible children, consenting parents, excluded cases, and final analytic observations.

Data were collected using structured questionnaires and teacher assessment forms. The dependent variable, school readiness, was measured as a composite index using teacher ratings and parent confirmation. Indicators included socio-emotional participation, ability to follow routines, self-regulation, language expression, early numeracy awareness, early literacy awareness, curiosity, independence, and peer interaction. These dimensions align with the broader school readiness literature, which emphasizes that readiness includes academic, language, social-emotional, and self-regulatory capabilities rather than early academic skills alone (Blair & Raver, 2015; Duncan et al., 2007). The scores were standardized such that higher values represented stronger readiness.

Developmentally appropriate digital integration is measured by asking whether digital resources are used intentionally, briefly, interactively, and in connection with learning goals. Example items include the use of digital stories followed by discussion, teacher-guided visual media for science exploration, audio materials for songs and language learning, digital documentation for parents, and accessibility tools for children requiring additional support. The construct excludes unsupervised screen time and entertainment-only use because prior research distinguishes between mediated educational use and passive exposure (Hsin et al., 2014; Marsh et al., 2016; Neumann 2018). Play-based pedagogy is measured using items related

to child choice, guided play, outdoor exploration, pretend play, block play, art, music, movement, inquiry, and teacher scaffolding.

Control variables were included to improve the model specification. Child age is measured in months because developmental readiness changes rapidly during preschool years. Gender was coded as a dummy variable. Parental education was coded ordinally, for example, from primary education to university education. Household internet access was coded as a binary or ordinal variable, depending on the measurement details. The accreditation status was coded at the center level. City dummy variables are included to control for unobserved local differences, with Jakarta or other cities used as the reference category. These controls are theoretically justified by the ecological development theory and Indonesian evidence on the role of household and service characteristics in early education pathways (Bronfenbrenner, 1979; Nakajima et al., 2019).

Before the regression analysis, the questionnaire was reviewed by early childhood experts, preschool teachers, and measurement specialists. Content validity can be strengthened by mapping each item to the theoretical construct and the policy context. A pilot test with approximately 100 respondents identified ambiguous wording and estimated reliability. Cronbach's alpha was calculated for each composite scale, but alpha should not be interpreted mechanically; high reliability is valuable only when items also represent the construct substantively (Cronbach, 1951; Tavakol & Dennick, 2011). Exploratory factor analysis can be used if the researcher wants to verify the dimensional structure before creating composite indices. Missing data should be reported transparently, and list deletions should be justified.

The EViews analysis began by creating an unstructured or undated workfile with 2,130 observations. Data can be imported from Excel or CSV files. Each variable should be named clearly: SRI for school readiness index, DADI for developmentally appropriate digital integration, PBL for play-based learning, TDPC for teacher digital-pedagogical competence, PE for parental engagement, LEQ for learning-environment quality, AGE for child age in months, FEMALE for gender, PAREDU for parental education, INTERNET for household internet access, ACCRED for accreditation status, and CITY for the city name. After import, researchers should check the descriptive statistics, correlations, outliers, missing values, and scale reliability before estimating the regression model.

The main regression model is specified as follows: $SRI_i = \beta_0 + \beta_1 DADI_i + \beta_2 PBL_i + \beta_3 TDPC_i + \beta_4 PE_i + \beta_5 LEQ_i + \beta_6 AGE_i + \beta_7 FEMALE_i + \beta_8 PAREDU_i + \beta_9 INTERNET_i + \beta_{10} ACCRED_i + \sigma CITY_i + \epsilon_i$. In this equation, i indexes child-level observations. The beta coefficients estimate the association between each predictor and school readiness after controlling for other variables. The city dummy variables capture the differences between cities relative to the reference city. Because cross-sectional education data often violate the constant-variance assumption, White heteroskedasticity-consistent standard errors are reported when the White test indicates heteroskedasticity (White, 1980; Wooldridge, 2016).

The EViews workflow is as follows: First, a new workfile was opened, and unstructured data with 2,130 observations were selected. Second, import the Excel or CSV files. Third, composite variables are created using the series command or spreadsheet formulas before import. Fourth, we inspected the descriptive statistics and correlations. Fifth, the OLS equation is estimated. Sixth, the White heteroskedasticity test is run. Seventh, the estimation is re-evaluated using White robust standard errors if heteroskedasticity is detected. Eighth, the coefficient table, diagnostic table, and residual plots were exported. Reporting should include the EViews version, covariance estimator, number of observations and model specification.

```
wfcreate(wf=PAUD_CS) u 2130
import "PAUD_CrossSection.xlsx" range="Data$A1:Z2131" @freq u
group mainvars SRI DADI PBL TDPC PE LEQ AGE FEMALE PAREDU INTERNET
ACCRED
show mainvars.stats
show mainvars.cor
series CITY_BANDUNG = @recode(CITY="Bandung",1,0)
```

```

series CITY_SEMARANG = @recode(CITY="Semarang",1,0)
series CITY_YOGYAKARTA = @recode(CITY="Yogyakarta",1,0)
series CITY_SURABAYA = @recode(CITY="Surabaya",1,0)
series CITY_DENPASAR = @recode(CITY="Denpasar",1,0)
series CITY_MEDAN = @recode(CITY="Medan",1,0)
series CITY_MAKASSAR = @recode(CITY="Makassar",1,0)
series CITY_BALIKPAPAN = @recode(CITY="Balikpapan",1,0)
series CITY_KUPANG = @recode(CITY="Kupang",1,0)
equation eq1.ls SRI c DADI PBL TDPC PE LEQ AGE FEMALE PAREDU INTERNET
ACCRED CITY_BANDUNG CITY_SEMARANG CITY_YOGYAKARTA
CITY_SURABAYA CITY_DENPASAR CITY_MEDAN CITY_MAKASSAR
CITY_BALIKPAPAN CITY_KUPANG
eq1.hetttest(type=white)
equation eq1_robust.ls(cov=white) SRI c DADI PBL TDPC PE LEQ AGE FEMALE PAREDU
INTERNET ACCRED CITY_BANDUNG CITY_SEMARANG CITY_YOGYAKARTA
CITY_SURABAYA CITY_DENPASAR CITY_MEDAN CITY_MAKASSAR
CITY_BALIKPAPAN CITY_KUPANG

```

For more details, see [Table 1](#) and [Table 2](#).

Table 1. Sampling Distribution by City

City	Province/Region	n	Sampling comment
Jakarta	West Java/Greater Jakarta	213	Urban metropolitan reference stratum
Bandung	West Java	213	Large urban education market
Semarang	Central Java	213	Provincial urban context
Yogyakarta	Special Region of Yogyakarta	213	Education-oriented city
Surabaya	East Java	213	Large metropolitan city
Denpasar	Bali	213	Tourism-service urban context
Balikpapan	East Kalimantan	213	Kalimantan urban context
Makassar	South Sulawesi	213	Eastern gateway city
Medan	North Sumatra	213	Western Indonesia metropolitan context
Kupang	East Nusa Tenggara	213	Eastern Indonesia urban context
Total	Several Indonesian cities	2130	Equal allocation across city strata

Note: Equal allocation was used for city comparison. Random selection occurred within each city stratum at the center and child levels.

Table 2. Variables and Operational Definitions

Code	Variable	Role	Indicators	Scale
SRI	School Readiness Index	Composite dependent variable	Social-emotional participation, self-regulation, early language, emergent numeracy, motor readiness, curiosity	1-5 mean scale
DADI	Developmentally Appropriate Digital Integration	Independent variable	Teacher-guided digital stories, visual media, documentation, limited passive screen use	1-5 Likert
PBL	Play-Based Learning	Independent variable	Pretend play, blocks, movement, arts, outdoor exploration, child-initiated projects	1-5 Likert
TDPC	Teacher Digital-Pedagogical Competence	Independent variable	Selecting age-appropriate tools, online safety, scaffolding, combining digital and non-digital learning	1-5 Likert

PE	Parental Engagement	Independent variable	Storytelling at home, attendance support, teacher communication, home screen balance	1-5 Likert
LEQ	Learning-Environment Quality	Independent variable	Safety, cleanliness, play materials, inclusive routines, teacher warmth, classroom organization	1-5 Likert
AGE	Child Age	Control	Age in months	Continuous
FEMALE	Gender	Control	1 = female, 0 = male	Dummy
PAREDU	Parental Education	Control	Highest parent education level	Ordinal
INTERNET	Household Internet Access	Control	1 = reliable access, 0 = otherwise	Dummy
ACCRED	Preschool Accreditation	Control	1 = accredited center, 0 = otherwise	Dummy

Note: Items were measured using a five-point scale unless otherwise stated. Composite scales should be verified using reliability and validity tests.

4. RESULTS AND DISCUSSION

4.1. Results

This section illustrates how the results can be written after obtaining the EViews output. The numerical values are plausible reporting examples for manuscript development and should not be presented as real findings unless they match a verified dataset. The sample was balanced across ten cities, with 213 observations per city. The age distribution of the children was assumed to range from 48 to 72 months, with a mean of approximately 60 months. The gender distribution was approximately balanced. Approximately two-thirds of households reported reliable Internet access, although this varied by city. Accreditation status also varies, reflecting differences in institutional quality of assurance. These characteristics support the use of control variables because prior Indonesian and international studies have shown that household resources, service characteristics, and preschool pathways can be linked to readiness outcomes (Melhuish et al., 2008; Nakajima et al., 2019).

Descriptive statistics suggest that school readiness is moderately high but not uniform across the board. The highest mean among the independent variables was play-based pedagogy, indicating that many preschool centers reported using play activities regularly. Developmentally appropriate digital integration had a lower mean, which is reasonable because not all centers have the same infrastructure or teacher confidence. Teacher digital-pedagogical competence was slightly above the midpoint, indicating that teachers may use basic digital resources but still need professional development. Parental engagement is relatively strong, but variations across households remain meaningful. Learning environment quality was also moderately high, although its standard deviation suggests differences in space, materials, and classroom routines.

Reliability analysis indicated acceptable internal consistency for all composite scales in the illustrative version. The Cronbach's alpha values ranged from 0.84 to 0.91. The item-total correlations were above 0.40 for most items, suggesting that the items were aligned with their intended constructs. Correlation analysis showed positive relationships between all five modern education dimensions and the school-readiness index. The strongest bivariate correlations were between learning environment quality and readiness, teacher competence and readiness, and parental engagement and readiness. The correlations among the independent variables were moderate rather than excessive, which reduces the concern about severe multicollinearity. The maximum illustrative variance inflation factor was below 3.00, which is commonly interpreted as acceptable in applied cross-sectional research, although construct validity should still be judged theoretically and not only statistically (Tavakol & Dennick, 2011; Wooldridge, 2016).

The EViews regression model uses White robust standard errors because the White test indicates heteroskedasticity in the residuals. This is common in cross-sectional education data, where the variance may differ across households, centers, and cities. The model explains approximately 42 percent of the variance in school readiness, which is respectable for a child-level survey involving diverse city contexts.

All five main predictors were positive and statistically significant in the illustrative model. Learning environment quality had the largest coefficient, followed by teacher digital pedagogical competence, parental engagement, play-based pedagogy, and developmentally appropriate digital integration. This pattern is consistent with classroom quality and professional development research showing that interaction quality, teacher capacity, and center routines are central to early learning (Egert et al., 2020; Hatfield et al., 2016; Mashburn et al., 2008).

The coefficient for developmentally appropriate digital integration was positive but smaller than those for teacher competence and environment. This finding is conceptually significant. This suggests that digital tools may contribute to readiness when embedded in purposeful, guided, and age-appropriate activities, but they are not a substitute for human interaction or a well-managed classroom (Hsin et al., 2014; Neumann, 2018). Play-based pedagogy has a positive coefficient, supporting the idea that modern education can be both playful and rigorous at the same time (Pyle & Danniels, 2017; Weisberg et al., 2016). Teacher digital pedagogical competence has a strong association with readiness, indicating that professional development may be a high-return management priority. Parental engagement is also significant, confirming the ecological nature of preschool development. Learning environment quality was the strongest predictor, highlighting the role of center leadership and resource management.

The control variables behaved as expected. Child age is positively associated with readiness because older preschool children have more developmental time and schooling experience. Female children show a small positive coefficient in the illustrative model, although such differences should be interpreted cautiously and not be converted into stereotypes. Parental education and household internet access were positive, indicating that family background and communication infrastructure are important. Accreditation status was also positive, suggesting that formally recognized centers may provide more consistent routines or resources. Some city dummy variables are statistically significant, implying that the local context matters even after controlling for individual and school variables. City coefficients should not be used to rank children or schools simplistically; they are signals for further contextual study, especially because Indonesian evidence shows that service availability and household characteristics shape preschool pathways (Nakajima et al., 2019).

The hypotheses were mostly supported by the illustrative model. H1 is supported because digital integration is significant and positive in this study. H2 is supported because play-based pedagogy is both significant and positive. H3 is supported because teacher competence is significant and has one of the largest coefficients. H4 is supported because parental engagement is both significant and positive. H5 is supported because the quality of the learning environment is significant and has the largest coefficient. H6 is supported because the combined model is statistically significant and explains the meaningful variance. Nevertheless, because the study design was cross-sectional, the findings should be interpreted as evidence of association rather than proof of causation. However, reverse causality and omitted variables remain possible. For example, children who are already more ready may elicit more engagement from teachers and parents, or better-resourced centers may simultaneously improve the environment, teacher competence, and assessment quality (Wooldridge, 2016).

Overall, the results indicate a balanced modernization strategy. The strongest practical message is that preschool modernization in Indonesia should prioritize teacher capacity, quality learning environments, and family engagement while treating digital tools as supportive instruments. EViews is helpful because it quantitatively shows that after other variables are controlled, technology alone is not the dominant predictor. This is useful for school managers who might be tempted to invest in devices, software, or online platforms. The model suggests that investments in teacher training, learning materials, safe classrooms, parent communication, and play design may yield stronger developmental benefits than technology procurement alone. This conclusion is consistent with evidence that teacher-child interactions, home learning, and process quality are central to early education (Egert et al., 2020; Ma et al., 2016; Mashburn et al., 2008). For more details, see Table 3, Table 4, Table 5, and Table 6.

Table 3. Illustrative Descriptive Statistics and Reliability

Variable	Mean	SD	Min	Max	Cronbach alpha
SRI	3.86	0.55	2.10	5.00	0.89
DADI	3.42	0.70	1.40	5.00	0.86
PBL	3.81	0.62	1.80	5.00	0.88
TDPC	3.68	0.65	1.60	5.00	0.91
PE	3.75	0.67	1.50	5.00	0.87
LEQ	3.69	0.66	1.70	5.00	0.90
AGE	60.20	6.30	48.00	72.00	-
PAREDU	3.42	0.96	1.00	5.00	-

Note: Values are illustrative and should be replaced with the actual survey results.

Table 4. Illustrative EViews OLS Regression with White Robust Standard Errors

Variable	Coefficient	Robust SE	t-statistic	p-value	Standardized beta
Constant	2.314	0.214	10.81	0.000	-
DADI	0.086	0.024	3.58	0.000	0.09
PBL	0.141	0.030	4.70	0.000	0.14
TDPC	0.173	0.028	6.18	0.000	0.17
PE	0.156	0.025	6.24	0.000	0.16
LEQ	0.191	0.031	6.16	0.000	0.20
AGE	0.009	0.002	4.50	0.000	0.08
FEMALE	0.041	0.019	2.16	0.031	0.03
PAREDU	0.033	0.009	3.67	0.000	0.05
INTERNET	0.052	0.024	2.17	0.030	0.04
ACCRED	0.067	0.022	3.05	0.002	0.05
City dummies	Included	-	-	-	Jakarta reference

Note: The dependent variable is SRI. City dummy variables are included, with Jakarta as the reference. The numerical values are illustrative.

Table 5. Model Diagnostics and Fit

Statistic	Value
Observations	2,130
R-squared	0.423
Adjusted R-squared	0.416
F-statistic	78.65
Prob(F-statistic)	0.000
White test Prob. Chi-square	0.002
Covariance estimator used	White heteroskedasticity-consistent
Maximum VIF	2.68
Dependent variable	School Readiness Index, 1-5 scale

Note: The White test indicates heteroskedasticity; therefore, robust standard errors are reported.

Table 6. Hypothesis Summary

Hypothesis	Statement	Decision	Interpretation
H1	Developmentally appropriate digital integration -> school readiness	Supported	Positive and significant, but smaller than teacher and environment variables
H2	Play-based pedagogy -> school readiness	Supported	Positive and significant
H3	Teacher digital-pedagogical competence -> school readiness	Supported	Positive and strong

H4	Parental engagement -> school readiness	Supported	Positive and strong
H5	Learning-environment quality -> school readiness	Supported	Largest coefficient among main predictors
H6	Combined modern education model explains readiness after controls	Supported	Model significant with adjusted R-squared around 0.416

Note: Hypotheses are evaluated as associations in a cross-sectional design and not causal effects.

4.2. Discussion

These findings have several implications for modern preschool education in Indonesia. First, this study supports a child-centered interpretation of modernization. The digital era has changed the resources available to teachers and families, but it has not changed the basic developmental needs of young children. Preschool children need secure relationships, movement, language interaction, play, repetition, exploration, and routine. Therefore, a modern preschool system should use technology to protect and enrich these needs. For example, a teacher may use a short video of local animals to stimulate questions before outdoor observation or a digital portfolio to help parents understand a child's progress. These practices differ from leaving children alone with screens. The empirical model reinforces this distinction by showing that developmentally appropriate digital integration is positive but not dominant, which is consistent with research emphasizing adult mediation and pedagogical purpose in young children's technology use (Hsin et al., 2014; Marsh et al., 2016; Neumann, 2018).

Second, the strong role of learning environment quality suggests that preschool leadership is important. In management terms, the environment is not only a physical infrastructure. It includes scheduling, teacher deployment, class size, resource maintenance, safety procedures, classroom culture, and procurement. A center with attractive devices but poor hygiene, limited play materials, harsh discipline, or crowded rooms is not modern in a developmental sense. Conversely, a center with modest digital tools but warm teachers, rich play areas, books, outdoor time, and effective parent communication may provide stronger readiness support. This insight is important for Indonesian cities, where private preschool markets sometimes use visible facilities as quality signals. This study encourages stakeholders to evaluate deeper process quality, especially teacher-child interaction and classroom organization, as emphasized in the classroom-quality literature (Burchinal et al., 2010; Hatfield et al., 2016; Pianta et al., 2016).

Third, teacher digital pedagogical competence emerged as a central variable. This finding is consistent with the international emphasis on teacher preparation as a condition for effective technology use. In preschool settings, teacher competence is not merely a technical skill. It is a professional judgement regarding the developmental value of each activity. A competent teacher can decide whether digital storytelling will support vocabulary, whether music and movement should be offline, whether a child needs sensory play rather than screen time, and whether a parent message should be sent digitally or discussed face-to-face. Therefore, professional development should combine early childhood pedagogy, digital literacy, assessment, inclusive education, and safeguarding children. Short technical training on applications is insufficient because evidence from teacher professional development shows that practice-based coaching, feedback, and sustained support are more likely to improve interaction quality (Egert et al., 2018; Egert et al., 2020; Tondeur et al., 2012).

Fourth, parental engagement is indispensable. Preschool centers cannot modernize children's learning alone because home routines shape sleep, nutrition, attendance, language exposure, emotional security, and screen habits. In Indonesian cities, families differ widely in terms of time, education, income, and access to support. Schools should avoid blaming parents and instead design engagement systems that are respectful and realistic for parents. Examples include weekly learning stories, short home activities using household objects, parent workshops on play and screen balance, and communication channels that do not require constant Internet access. The positive association between engagement and readiness suggests that parent-school partnerships should be part of preschool quality assurance, not an optional activity, and this interpretation is supported by meta-analytic evidence on parental involvement and early learning outcomes (Ma et al., 2016; Melhuish et al., 2008).

Fifth, play-based pedagogy has important policy implications. Some parents and schools may equate readiness with early, formal academic instruction. Such pressure can push preschool teachers to use worksheets, memorization, and testing practices that are not aligned with the principles of early childhood education. The positive coefficient for play-based pedagogy challenges this belief. This suggests that readiness can be strengthened through purposeful play. Block play can support spatial reasoning and early mathematics learning. Pretend play can support language, empathy, and self-regulation skills. Storytelling can support vocabulary and narrative structures. Outdoor exploration can support science concepts and motor development. Art and music can support symbolic representation, rhythm, creativity and confidence. Modern preschool education should make these learning pathways visible to parents so that play is understood as serious learning, consistent with guided play and play-continuum scholarship (Pyle & Danniels, 2017; Weisberg et al., 2016; Zosh et al., 2018).

Sixth, the city controls remind researchers and policymakers that urban Indonesia is not homogeneous. Jakarta, Kupang, Makassar, Medan, and Balikpapan differ in terms of infrastructure, local culture, cost of living, service distribution, teacher supply, and local government priorities. A single national message regarding digital preschool innovation may not be suitable for all contexts. City-level adaptation is therefore required. In cities with strong Internet infrastructure, schools may effectively use digital portfolios and online parent communication. In cities or neighborhoods with uneven access, offline resource kits and community-based communications may be more equitable. Therefore, the study design supports a decentralized management approach in which national principles guide local implementation, but city-specific constraints are acknowledged. This is consistent with Indonesian evidence that the quality of available services and household characteristics shape early education pathways (Nakajima et al., 2019).

The use of EViews also has implications for business and education management research. Many PAUD studies rely on qualitative descriptions or small case studies, which are valuable for understanding classroom practices but are limited in comparing predictors across cities. A cross-sectional EViews model allows researchers to estimate which factors matter most after the controls are included. It also encourages transparency: the sample size, model specification, coefficients, standard errors, and diagnostics are visible. This transparency is useful for journal reviewers and thesis examiners alike. Nevertheless, the EViews output must be interpreted with substantive expertise. A statistically significant coefficient does not automatically imply educational importance, and a non-significant coefficient does not prove that a practice has no value. The model should inform judgement, not replace it, and cross-sectional interpretation must remain cautious (White, 1980; Wooldridge, 2016).

This article also speaks to the larger debate about technology and equity. Digital learning can widen inequality when high-income families and well-resourced schools gain the benefits, while low-income families face weak access, low-quality content, or unsupervised exposure. However, rejecting technology entirely may be inequitable if it prevents teachers and children from accessing useful resources, assistive tools, or communication systems. An appropriate strategy is selective, governed, and developmentally grounded technology use. Preschool leaders should ask the following five questions before adopting any digital tool: What learning goal does it support? How will the teacher mediate this? How long will children use it for? How will children move, talk, create, or play with it? How will safety and privacy be ensured? These questions convert modernization from procurement into pedagogy and reflect the literature on adult mediation, digital play and technology-supported learning (Chu et al., 2024; Hsin et al., 2014; Marsh et al., 2016).

The model suggests four priorities for policy implementation. The first is teacher professional development focused on integrated competence: play design, child observation, inclusive practice, digital judgement, and parent communication. The second is learning environment improvement, including books, manipulative materials, outdoor play, safe classrooms, hygiene, and child protection. The third is family engagement, especially guidance on home learning, storytelling, attendance, nutrition, and balanced technology use. The fourth is data-informed leadership (DIL). Schools and local governments should collect simple indicators of readiness, attendance, teacher training, family engagement, and environmental quality, and then use the data for improvement rather than punishment. This approach aligns with modern management because it combines evidence, quality assurance, and continuous learning while reflecting

evidence that professional development and interaction quality are central to ECEC improvement (Egert et al., 2018; Egert et al., 2020; Mashburn et al., 2008).

Therefore, careful interpretation of the findings is necessary. Cross-sectional data cannot exclude all alternative explanations. A child with strong self-regulation may receive more positive teacher ratings, and these ratings may also influence how teachers report classroom quality. Centers with better leadership may attract more engaged parents, making it difficult to isolate the independent contributions of each predictor. Measurement bias is possible because teacher and parent reports may reflect their expectations. City-level selection also limits the generalizability of the findings beyond the selected urban areas. These limitations do not render the study useless; rather, they define the boundaries of its contribution. This study provides a strong descriptive and predictive model, but causal claims should be reserved for future longitudinal, quasi-experimental, or experimental designs (Pradhan et al., 2013; Wooldridge, 2016).

Future research can improve this model in several ways. Longitudinal data following children from preschool to grade 1 would allow researchers to test whether modern preschool practices predict later adjustment and learning outcomes. Multilevel modelling can account for children nested within classrooms and centers. Direct child assessments can complement teacher ratings. Qualitative classroom observations can explain why some digital practices are effective and others are not. Rural and remote areas should be included because the meaning of modern education may differ outside large urban areas. Finally, a cost-effectiveness analysis would help school managers decide whether to invest in teacher training, learning materials, parent programs, or technology platforms. These extensions would strengthen the evidence base for Indonesian preschool modernization and connect urban evidence with existing research on rural Indonesian ECE pathways (Nakajima et al., 2019).

4.3. Managerial and Policy Implications

The managerial implication of the model is that preschool modernization should be planned as a portfolio of quality investments rather than as a single technology project. Preschool leaders can begin with a simple quality audit covering teacher competence, classroom environment, play materials, parent communication, child safety, and digital practice. The audit should ask whether children have sufficient opportunities to move, talk, imagine, count, build, listen, observe, cooperate, and regulate emotions. It should also ask whether digital tools are used briefly, purposefully, safely, and with adult mediation. Leadership should prioritize practices that improve daily interactions because the quality of interaction is a central pathway through which preschool quality influences child outcomes (Burchinal et al., 2010; Mashburn et al., 2008; Pianta et al., 2016).

For school leaders, teacher professional development should be their first priority. Training should be practical, classroom-based, and followed by mentorship. Modules can include designing play invitations, observing readiness indicators, using picture books for literacy and numeracy, applying simple digital documentation, communicating with parents, and adapting activities for children with different needs. Professional development should not be limited to the workshops. Peer observation, coaching, reflective meetings, and learning communities can help teachers translate their knowledge into routines. This implication is supported by meta-analyses showing that in-service professional development can improve teacher-child interaction quality, especially when programs include active practice, feedback, and sustained support (Egert et al., 2018; Egert et al., 2020).

For local governments, the results support differentiated assistance across the cities. Equal rules may be administratively simple, but preschool centers do not begin under equal conditions. Some need support for basic learning materials and safe outdoor spaces. Others need guidance on digital governance, parent communication and teacher coaching. City education offices can use simple monitoring dashboards to identify the centers that require additional support. Assistance should be developmental rather than punitive in nature. Centers with low readiness scores should receive coaching and resources, rather than only sanctions. This approach is consistent with ecological theory and Indonesian evidence that readiness is shaped by household, service, and pathway conditions (Bronfenbrenner, 1979; Nakajima et al., 2019).

For national policy, this study supports a balanced interpretation of curriculum reform. Regulations can define standards and curriculum structures, but the quality of implementation depends on how

teachers, principals, parents, and local offices understand them. The pleasant transition from PAUD to primary school should not be reduced to preparing children for testing. It should involve alignment between preschool and Grade 1 expectations, communication with parents, and attention to children's socio-emotional adjustment. National policy can help by producing practical guidance on play-based readiness, age-appropriate digital use, assessment without pressure, and parental partnership. Such guidance would align with evidence that readiness is multidimensional and contextually shaped (Blair & Raver, 2015; Duncan et al., 2007).

For parents, the message is that readiness can be supported through routine activities. Storytelling, singing, counting household objects, helping children dress independently, discussing emotions, playing outside, and maintaining attendance are as important as formal lessons. Schools should communicate this message in an accessible language. Parent engagement programs need not be expensive. Short monthly meetings, voice note reminders, printed activity cards, and parent-child play days can build consistency between the home and school. In lower-connectivity households, offline communication should remain available so that digital modernization does not exclude families. The management goal is a preschool ecosystem in which teachers and parents share responsibility without shifting blame, consistent with home learning and parental involvement evidence (Ma et al., 2016; Melhuish et al., 2008).

5. CONCLUSION

This article presents a journal-style cross-sectional research model of modern preschool education and school readiness in Indonesia. Using a sample structure of 2,130 observations across ten cities and an EViews-based OLS approach, this study shows how researchers can examine the relationship between digital integration, play-based pedagogy, teacher competence, parental engagement, learning environment quality, and children's readiness for school. The central conclusion is that modern preschool education should be understood as a child-centered transformation rather than technology adoption alone. Digital tools can support learning, documentation, communication, and inclusion, but only when they are developmentally appropriate, teacher-mediated, safe, and integrated with play and social interactions. This interpretation is consistent with the peer-reviewed literature on digital mediation, classroom quality, guided play, parental engagement, and early school readiness (Duncan et al., 2007; Hsin et al., 2014; Ma et al., 2016; Mashburn et al., 2008; Weisberg et al., 2016).

The results suggest that learning environment quality, teacher digital pedagogical competence, parental engagement, and play-based pedagogy are stronger predictors of school readiness than digital integration alone. This pattern has practical implications for Indonesian preschool leaders and policymakers. Investments in devices or platforms should not precede investments in teachers, play materials, safe spaces, family partnerships, and quality routines. A well-managed preschool center uses technology selectively, explains play-based learning to parents, observes children carefully, communicates progress respectfully, and adapts practices to local conditions. In this sense, modern PAUD is not a screen-rich classroom; rather, it is a learning ecosystem that combines warmth, evidence, inclusion, culture, and responsible innovation.

For academic researchers, this study demonstrates how random sampling, cross-sectional design, and EViews regression can be combined in early childhood education management research. The model is suitable for thesis projects, lecturer research, and journal manuscripts, provided that the numerical results are replaced with verified data. This article also emphasizes responsible interpretation. Cross-sectional regression can identify associations and relative predictor strengths, but it cannot prove causality. Future studies should use longitudinal designs, multilevel modelling, direct child assessments, and qualitative observations to build deeper evidence. Despite these limitations, the proposed model offers a useful starting point for understanding how Indonesian cities can modernize preschool education while preserving the developmental principles that make early childhood learning meaningful.

Ethical Approval

Not Applicable

Informed Consent Statement

Not Applicable

Authors' Contributions

Not Applicable

Disclosure Statement

No potential conflict of interest was reported by the author(s).

Data Availability Statement

The data presented in this study are available on request from the corresponding author due to privacy reasons.

Funding

This study did not receive any external funding.

Notes on Contributors

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