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Factors Shaping Digital Learning Material Use in Primary Schools: An Exploratory Factor Analysis Approach

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ABSTRACT: The utilization of digital learning materials in education, particularly in primary education, is becoming an increasingly prominent trend in the context of the Fourth Industrial Revolution. To assist teachers in adapting to these new educational trends, the strategic implementation of digital learning materials in schools plays a critical role in improving the teaching and learning processes. Despite the anticipated positive impact of digital learning material use on educational activities, significant challenges remain, including infrastructure issues, appropriate policies, digital content, support devices, support capabilities, and deployment capabilities in the digital environment, as well as human-related operational issues. The objective of this study is to explore the factors influencing teachers' use of digital learning materials in primary schools in the urban central of Vietnam. The validity and reliability of the "assessment of factors affecting the use of digital learning materials" instrument was examined using SPSS for exploratory factor analysis (EFA), to determine reliability and extract prominent factors. Through factor analysis employing Varimax rotation, 33 items were retained in the questionnaire. Analysis of the results from 129 respondents revealed four factors affecting the use of digital learning materials, with a KMO measure of sampling adequacy of 0.943 and Bartlett's test of sphericity indicating a Chi-Square with Sig value of 0.000 < 0.05. The findings suggest four groups of factors, providing guidance for teachers and students in identifying the key factors that enhance the effective use of digital learning materials in schools.

KEYWORDS: Digital learning materials, Determinants, Primary education, Technology application, Exploratory factor analysis.

I. INTRODUCTION

In the current context, education is undergoing comprehensive and robust innovation, and educational training needs to focus on high-quality human resources to meet the burgeoning demands of technology and digital science. It is evident that the role of technological devices and digital learning materials in teaching cannot be separated [1]. Digital learning materials, also known as Digital Educational Resources or Digital Learning Resources, are digitized learning materials structured, formatted, and scripted in a certain way, stored on computers or online to facilitate teaching and learning via computers/technological means. The digitized formats can include text, slides, data tables, audio, images, video clips, interactive applications, and integrated products from the previously mentioned formats [2,3]. These materials can comprise text, images, audio, video, simulations, interactive software, and various other digital formats, accessed and utilized through electronic devices such as computers, tablets, smartphones, and other mobile devices [3, 4]. Most authors highlight the basic characteristics of digital learning

materials as follows: (1) Digitized learning materials, (2) Serving the purpose of teaching and learning, (3) Stored on electronic media, websites, or cyberspace, (4) Accessible and searchable using technological means.

With exceptional advantages such as intangibility, diversity, interactivity, timeliness, and flexibility, digital learning materials play a crucial role in modern educational innovation [5]. Digital learning materials not only provide more engaging experiences compared to traditional learning materials but also enhance the quality of teaching and learning. Furthermore, they facilitate the personalization of learning, meeting the diverse learning needs of students in the digital age. With numerous advantages, such as increasing interactivity and engagement in the learning process, enabling flexible and personalized learning, digital learning materials give opportunities for accessing a wealth of diverse knowledge and online resources. Students can access lectures, e-books, images, and videos from online resources [3,5,6]. Despite offering many benefits for teaching and learning, digital learning materials also present certain challenges in their effective development and utilization. For instance, some teachers are not fully aware of the role and benefits of digital learning materials and are hesitant to use them; the infrastructure for education is often inadequate and inconsistent, and many teachers' technical skills are insufficient due to a lack of comprehensive training in this area. Additionally, the content of digital learning materials may not always be scientifically sound or suitable for learners' cognitive characteristics.

In a detailed analysis of the use of digital learning materials in teaching, Van den Akker and colleagues (2003) argue that teachers play a crucial role in integrating educational and technological concepts [3]. Additionally, many teachers, especially younger ones, have a strong demand for enhancing their information technology skills and developing the ability to apply technology in their teaching practices [1,7]. Therefore, orienting awareness and skills in using technology in education, particularly in the development and utilization of digital learning materials, must consider the primary factor of the individuals involved in this process. This also facilitates the creation of a constructivist teaching environment [8,9]. Moreover, teachers should guide students in accessing digital learning materials [10]. Currently, numerous digital learning materials are being applied in teaching, such as electronic lectures (videos, audiobooks, etc.), presentations (PowerPoint, Google Slides, Canva, etc.), electronic textbooks, or various electronic course materials [3,4]. However, research into the factors influencing the orientation towards the development and use of digital learning materials in primary education has not been thoroughly explored and clarified by researchers.

This paper aims to investigate the factors influencing the use of digital learning materials by teachers in primary schools, employing the exploratory factor analysis method. The findings from this study will provide valuable insights for educators on effectively utilizing technological applications and further enhancing the quality of online platforms to support teachers' instructional purposes.

II. MATERIALS AND METHODS

A. Participants

Information about the survey participants was collected through a questionnaire. The content of the survey included demographic details such as gender, age, work experience, work unit, and the frequency of using digital learning materials in teaching. The survey was conducted by sending a Google Form link to primary school teachers in both public and private urban schools in central Vietnam via Zalo from March 15, 2024, to March 25, 2024. Approximately 250 teachers voluntarily received the survey link, with 217 responses, resulting in an 86.8% response rate. After data collection, the research team discarded 88 invalid samples due to uniform responses or incomplete surveys. The final dataset used for analysis comprised 129 valid responses (59.5%). The information obtained from these 129 teachers will provide a deeper understanding of the characteristics of the study population and their perspectives on the use of digital learning materials, thereby enabling accurate and reliable conclusions.

Table 1 summarizes the data from the online survey. The proportion of male participants is 11.63%, while the proportion of female participants is 88.37%. The female teacher participation rate is significantly higher than that of male teachers (7.6 times higher). This disparity may reflect the gender imbalance in the primary education sector. The age distribution of teachers is as follows: under 25 years old - 8 (6.2%), 25 to 29 years old - 17 (13.18%), 30 to 34 years old - 35 (27.13%), 35 to 39 years old - 20 (15.5%), and over 39 years old - 49 (37.99%). Regarding work experience, teachers with less than 2 years of experience constitute 10 (7.75%), 2-5 years of experience - 24 (18.6%), 6-10 years of experience - 25 (19.39%), 11-15 years of experience - 31 (24.03%), and over 15 years of experience - 39 (30.23%). It is notable that the age group 30-39 constitutes the highest proportion (53.42%), indicating that the survey participants are primarily mature and experienced primary school teachers. Regarding the type of school, public schools account for 97.67%, while private schools account for 2.33%. The frequency of using digital learning materials in teaching is as follows: 1-2 times - 10.08%, 3-4 times - 25.58%, more than 5 times - 62.01%, and other

responses (specifically, frequently) account for 2.33%. This data illustrates the prevalent application of technology in primary school teaching.

Table 1. Demographic information of participants (N = 129)

Variable		*Frequency*	*Percentage*
Gender	Male	15	11.63
	Female	114	88.37
Age	Under 25 years old	8	6.2
	25 to 29 years old	17	13.18
	30 to 34 years old	35	27.13
	35 to 39 years old	20	15.5
	Over 39 years old	49	37.99
Educational Qualification	College	14	10.85
	University	109	84.5
	Postgraduate	6	4.65
Work Experience	Less than 2 years	10	7.75
	2 to 5 years	24	18.6
	6 to 10 years	25	19.39
	11 to 15 years	31	24.03
	More than 15 years	39	30.23
Workplace	Public School	126	97.67
	Private School	3	2.33
Frequency of Using Digital Learning Materials	1 to 2 times	13	10.08
	3 to 4 times	33	25.58
	More than 5 times	80	62.01
	Other	3	2.33
Total		129	100%

B. Survey Instruments

In this study, we utilized a questionnaire to survey the factors influencing primary school teachers' use of digital learning materials in teaching. This questionnaire comprises 33 questions designed to assess various aspects related to the use of digital learning materials in the teaching and learning process, such as expected effectiveness, expected effort, social influence, facilitating conditions, practicality of digital learning materials, motivation, behavioral habits, and behavioral intentions. Each question is measured using a five-point Likert scale (1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree). The content of the questions is presented in Table 2 below:

Table 2. Questions used to survey participants

Q1	Digital learning materials help students understand lessons visually.
Q2	Digital learning materials encourage students to be active and creative in their learning.
Q3	Digital learning materials enhance teaching effectiveness for teachers.
Q4	Using digital learning materials provides teachers with more opportunities to achieve teaching objectives.
Q5	Digital learning materials save time and effort compared to traditional teaching materials.
Q6	Digital learning materials are convenient and easily accessible.
Q7	Teachers do not encounter difficulties in developing skills to use digital learning materials.
Q8	Teachers clearly understand how to interact online using digital learning platforms.
Q9	Using digital learning materials is easy for teachers.
Q10	Colleagues encourage the use of digital learning materials.
Q11	Leaders facilitate the use of digital learning materials for teachers.
Q12	Parents support the use of digital learning materials in the teaching and learning process.
Q13	The infrastructure at your school supports the use of digital learning materials.

Q14	School leaders facilitate teacher training during the teaching process.
Q15	The internet access at your school is reliable.
Q16	Teachers have the knowledge and skills to use modern technology.
Q17	Digital learning materials are stable in terms of network connectivity during use.
Q18	Digital learning materials can be used on various electronic devices.
Q19	Digital learning materials provide rich and diverse resources.
Q20	Digital learning materials facilitate student self-study and exploration.
Q21	Learning through digital learning materials stimulates student interest.
Q22	Student interest in digital learning materials.
Q23	Digital learning materials meet the diverse needs and learning styles of individual students.
Q24	Digital learning materials make teaching more interesting and inspiring for teachers.
Q25	Teachers tend to use digital learning materials in their teaching.
Q26	Teachers use digital learning materials naturally and proficiently.
Q27	Teachers frequently participate in technology and digital learning materials courses.
Q28	Teachers use multiple functions of digital learning materials (online teaching, lectures, games, assessments, etc.).
Q29	Teachers use digital learning materials to support their teaching process.
Q30	Teachers frequently participate in technology and digital learning materials courses.
Q31	Teachers plan to continue using digital learning materials.
Q32	Teachers will recommend digital learning materials to friends/colleagues.
Q33	Teachers apply many digital learning materials in their teaching process.

C. Data Analysis

This study employs Exploratory Factor Analysis (EFA) to analyze the data. EFA is a quantitative research method that uses statistical techniques to identify the underlying structure of a dataset, typically involving observed variables in social, psychological, and educational studies, while retaining most of the information content from the original variable set [11]. EFA helps to uncover latent factors that may explain the relationships between observed variables, thereby simplifying the analytical model. The EFA process includes constructing the correlation matrix, extracting factors, determining the number of factors, rotating factors for easier interpretation, and naming the factors. EFA is commonly applied to develop and validate scales, aiding researchers in effectively exploring the latent structure within the data.

Through EFA, we aim to identify the underlying structure of a set of related variables. The assumption is that each indicator in the set is a linear function of one or more common factors and a unique factor. The common factors are latent, unobservable variables that influence more than one indicator in the set. The unique factor is a latent variable assumed to affect only one indicator in the set and does not account for the correlation of the indicator [12].

Before conducting EFA, the suitability of the measurement for the 33 survey items was assessed using descriptive statistics. In the descriptive statistics table, the research team calculated the mean value of all responses and the standard deviation (SD) for each question. If the mean of an item was found to be close to 1 or 5, the research team excluded that item from the table as it could reduce the correlation standard among the remaining items [13]. Following this step, the normality of the distribution was checked using skewness and kurtosis tests. After confirming the normality of the distribution, the exploratory factor analysis was conducted using SPSS 26 (Statistical Package for the Social Sciences).

III. RESULTS AND DISCUSSION

The EFA process begins with the extraction of eigenvalues for each factor. The Kaiser-Meyer-Olkin (KMO) measure is then employed to assess the adequacy of the data for factor analysis [14]. The KMO index measures the sampling adequacy for EFA, with values ranging from 0 to 1. Values greater than 0.5 are considered sufficient for EFA [15]. Bartlett's test is used to determine whether the correlations between the questions are strong enough for meaningful factor analysis [11]. Further analyses are only conducted if Bartlett's test is statistically significant. Bartlett's Test of Sphericity is used to test the hypothesis that the correlation matrix is an identity matrix, indicating that the variables are uncorrelated with each other.

Initially, 33 questions were proposed. After conducting several verification procedures, all the questions were deemed adequate and retained for the exploratory factor analysis.

Table 3. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.943
Bartlett's Test of Sphericity	Approx. Chi-Square	4785.488
	df	528
	Sig.	.000

EFA was conducted on the 33 questions using Varimax rotation. The analysis results from the SPSS software enabled the research team to extract eigenvalues for each factor. The KMO measure confirmed the sampling adequacy for the analysis with a value of 0.943 (see Table 3), which is higher than the 0.6 recommended by Kaiser [16] and the 0.5 suggested by Kim [15]. A KMO value close to 1 indicates a very high level of sample adequacy for factor analysis. According to Kaiser's classification (1974), a KMO value above 0.9 is considered excellent, affirming that the data is suitable for conducting factor analysis.

Bartlett's Test of Sphericity yielded results of $\chi 2$ (528) = 4785.488, $\rho < 0.000$, with 528 degrees of freedom, indicating that the correlations among the survey items are sufficiently large to conduct EFA. This result demonstrates a high level of significance ($p < 0.05$), rejecting the null hypothesis that the correlation matrix is an identity matrix. This means that the observed variables are sufficiently correlated to proceed with factor analysis.

The KMO and Bartlett's Test indicators both demonstrate that the collected data is adequate and highly suitable for conducting EFA. Specifically, the high KMO value (0.943) indicates a very good fit of the data sample, while the results of Bartlett's Test show significant correlations among the variables, confirming that applying EFA to this dataset is reasonable and reliable. These results enable researchers to proceed with subsequent factor analysis steps to explore the latent structure of the data.

A. Exploratory Factor Analysis

The results of the EFA presented in Table 4 display the eigenvalues, total variance explained, and the cumulative percentage of variance for the factors extracted from the dataset. This analysis was conducted using Principal Component Analysis (PCA). The eigenvalues represent the amount of variance attributed to each original factor in the data. Typically, factors with eigenvalues greater than 1 are retained. Additionally, after extracting the factors, the total variance explained by these factors remains the same as initially. The rotation process clarifies the factor structure, making it easier to interpret. The rotation method used here indicates that the variance has been redistributed among the factors.

The data in Table 4 indicate that four main factors were derived from the 33 questions, each with an eigenvalue greater than 1. The EFA results extracted these four principal factors from the data, explaining 74.880% of the total variance. This highlights the significance of the factors influencing the use of digital learning materials by teachers in primary schools, with the remainder attributed to other factors. The percentage of variance explained by each factor is as follows: Factor 1 (62.203%), Factor 2 (4.788%), Factor 3 (4.137%), and Factor 4 (3.752%). The cumulative variance explained totals 74.880%, consistent with the initial results. The cumulative variance explained after rotation remains unchanged compared to the pre-rotation results.

The EFA results identified four principal factors extracted from the data, explaining 74.880% of the total variance. The redistribution of variance after rotating the factors clarifies the factor structure and facilitates easier interpretation. Factor 1 accounts for the largest proportion with 23.933% of the variance, while the remaining factors reasonably explain the rest of the variance. This outcome provides a solid foundation for subsequent analyses and enhances the understanding of the latent structure of the dataset.

Table 4. Eigenvalue, Total Variance Explained of Factors

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	20.527	62.203	62.203	20.527	62.203	62.203	7.898	23.933	23.933
2	1.580	4.788	66.991	1.580	4.788	66.991	6.693	20.281	44.214
3	1.365	4.137	71.128	1.365	4.137	71.128	6.464	19.587	63.801
4	1.238	3.752	74.880	1.238	3.752	74.880	3.656	11.079	74.880
5	.907	2.749	77.629						
6	.755	2.288	79.917						
7	.667	2.021	81.938						
8	.548	1.661	83.599						
9	.507	1.535	85.134						

Extraction Method: Principal Component Analysis.

The Rotation Matrix from Table 5 shows the loadings of each question on the respective factors after rotation. Each loading represents the degree of association between a question and a specific factor, with higher loadings indicating stronger relationships. This analysis clarifies the factor structure and facilitates the interpretation of similar groups of questions. Table 5 presents the loadings for each item under a specific factor. Factor loadings describe each factor and the structure within the set of variables. For interpretive purposes, factor loadings of .30 or higher are considered significant with a sample size of 129 [25]. Using this loading threshold, we can observe that all loadings are significant. Furthermore, Table 5 reports that each variable has only one significant loading on one factor. Factor 1 includes 15 variables, Factor 2 comprises 9 variables, Factor 3 contains 6 variables, and Factor 4 consists of 3 variables.

Table 5. Rotation Matrix[a]

	Factor			
Questions	1	2	3	4
Q13	.765			
Q14	.719			
Q10	.698			
Q15	.674			
Q12	.641			
Q18	.633			
Q22	.626			
Q21	.615			
Q11	.613			
Q19	.609			
Q17	.596			
Q24	.574			
Q23	.559			
Q20	.540			
Q16	.444			
Q30		.730		
Q27		.670		
Q32		.621		
Q29		.621		
Q31		.597		
Q26		.594		
Q33		.584		
Q28		.562		
Q25		.525		
Q03			.775	
Q04			.763	
Q02			.751	
Q05			.726	
Q01			.713	
Q06			.476	
Q07				.716
Q08				.680
Q09				.662

Table 6 presents the naming of the factors extracted from the EFA, based on the questions with high loadings in each factor. Each factor is named to reflect the nature of the constituent questions.

Table 6. Naming the Factors

Component 1: Support and Environmental Conditions		**Loading**
Q13	The infrastructure at your school supports the use of digital learning materials.	.765
Q14	School leaders facilitate teacher training during the teaching process.	.719
Q10	Colleagues encourage the use of digital learning materials.	.698
Q15	The internet access at your school is reliable.	.674
Q12	Parents support the use of digital learning materials in the teaching and learning process.	.641
Q18	Digital learning materials can be used on various electronic devices.	.633
Q22	Student interest in digital learning materials.	.626
Q21	Learning through digital learning materials stimulates student interest.	.615
Q11	Leaders facilitate the use of digital learning materials for teachers.	.613
Q19	Digital learning materials provide rich and diverse resources.	.609
Q17	Digital learning materials are stable in terms of network connectivity during use.	.596
Q24	Digital learning materials make teaching more interesting and inspiring for teachers.	.574
Q23	Digital learning materials meet the diverse needs and learning styles of individual students.	.559
Q20	Digital learning materials facilitate student self-study and exploration.	.540
Q16	Teachers have the knowledge and skills to use modern technology.	.444
Component 2: Readiness and Technological Skills		
Q30	Teachers frequently participate in technology and digital learning materials courses.	.730
Q27	Teachers frequently participate in technology and digital learning materials courses.	.670
Q32	Teachers will recommend digital learning materials to friends/colleagues.	.621
Q29	Teachers use digital learning materials to support their teaching process.	.621
Q31	Teachers plan to continue using digital learning materials.	.597
Q26	Teachers use digital learning materials naturally and proficiently.	.594
Q33	Teachers apply many digital learning materials in their teaching process.	.584
Q28	Teachers use multiple functions of digital learning materials (online teaching, lectures, games, assessments, etc.).	.562
Q25	Teachers tend to use digital learning materials in their teaching.	.525
Component 3: Effectiveness and Creativity in Learning		
Q03	Digital learning materials enhance teaching effectiveness for teachers.	.775
Q04	Using digital learning materials provides teachers with more opportunities to achieve teaching objectives.	.763
Q02	Digital learning materials encourage students to be active and creative in their learning.	.751
Q05	Digital learning materials save time and effort compared to traditional teaching materials.	.726
Q01	Digital learning materials help students understand lessons visually.	.713
Q06	Digital learning materials are convenient and easily accessible.	.476
Component 4: Digital Interaction Skills		
Q07	Teachers do not encounter difficulties in developing skills to use digital learning materials.	.716
Q08	Teachers clearly understand how to interact online using digital learning platforms.	.680
Q09	Using digital learning materials is easy for teachers.	.662

The proposed factors are named as: Support and Environmental Conditions, Readiness and Technological Skills, Effectiveness and Creativity in Learning, and Digital Interaction Skills. Thus, naming the factors based on the questions with high loadings helps clearly identify the critical aspects of using digital learning materials in teaching. These factors provide a foundation for developing strategies to enhance the use of digital learning materials, ranging from improving infrastructure and technical support to offering training and developing technological skills, with the aim of maximizing the effectiveness of digital learning materials in education.

B. Discussion and Limitations

The EFA conducted in this study aimed to identify the latent factors related to the use of digital learning materials in teaching. The analysis results extracted four main factors, each representing a significant aspect of digital learning material usage. Below is a detailed discussion of each factor and its implications for research and educational practice.

The first factor is "Support and Environmental Conditions" This factor includes variables related to infrastructure, support from school leadership, colleagues, and parents, as well as the convenience and accessibility of digital learning materials. The high loadings of variables such as the state of infrastructure (Q13), facilitation by school leadership (Q14), and encouragement from colleagues (Q10) indicate that a supportive environment is crucial for teachers to effectively use digital learning materials. This implies that educational administrators need to invest in infrastructure and create a supportive environment to encourage teachers to adopt digital learning materials in their teaching.

The second factor is "Readiness and Technological Skills" This factor focuses on the level of participation in technology courses, proficiency in using digital learning materials, and the intention to continue using digital learning materials. Variables such as participation in technology courses (Q30, Q27) and the natural and proficient use of digital learning materials (Q26) have high loadings, indicating that teachers' readiness and technological skills are key factors. This suggests that providing training courses and support for developing technological skills for teachers is essential to enhance the effective use of digital learning materials.

The third factor is "Effectiveness and Creativity in Learning" This factor includes variables related to the benefits of digital learning materials for teaching effectiveness and fostering creativity in student learning. High loadings of variables such as enhancing teaching effectiveness (Q03), encouraging student creativity (Q02), and saving time (Q05) indicate that digital learning materials play a crucial role in improving the quality of teaching and learning. Therefore, promoting the use of digital learning materials can bring significant benefits to both teachers and students, enhancing the overall quality of education.

The fourth factor is "Digital Interaction Skills" This factor assesses teachers' ability to interact with and utilize digital learning platforms. Variables such as not encountering difficulties in developing skills to use digital learning materials (Q07) and clearly understanding how to interact with digital learning materials (Q08) have high loadings, indicating that teachers' interaction skills with digital learning materials are crucial. This suggests that ongoing support and training are necessary to help teachers become proficient in using digital learning materials, ensuring the effectiveness of the remote teaching process.

This study also has some limitations. The first limitation is that EFA focuses on extracting the principal factors with large variances, potentially overlooking smaller but practically significant factors. This may result in the loss of important information in the analysis. The second limitation is that other factors were not considered or analyzed in this study. There could be many important factors directly affecting teachers' use of digital learning materials that were not observed or measured, such as cultural and social factors. The final limitation is that EFA is typically applied to a specific sample and may not be generalizable to other groups. This is particularly important in the educational context, where cultural differences, teaching environments, and infrastructure can influence the results. To address this limitation and increase the generalizability of the EFA results, researchers should apply diverse sampling methods, conduct repeated studies, use supplementary analysis methods, and test for cultural generalizability. These steps help ensure that the extracted factors are accurately representative and applicable to various contexts, especially in the education field, which is subject to cultural, teaching environment, and infrastructure variability.

IV. CONCLUSIONS

Using digital learning materials in education is crucial amid the government's digital transformation alongside the economic and societal shifts. This study investigates factors influencing primary school teachers' use of digital learning materials in the Central region of Vietnam. Thirty-three questionnaire items were proposed based on prior research and distributed to participants via the Zalo social network. Based on valid evidence from 129 collected samples, the study successfully identifies four main factors influencing primary school teachers' use of digital learning materials including: Environmental support and conditions, Technological readiness and skills, Effectiveness and creativity in learning, and Digital Interaction Skills. Each factor represents a critical aspect in integrating and utilizing digital learning resources in teaching, providing valuable insights for researchers and educational practitioners. These findings can serve as reference materials for future studies or as foundational issues for further research by scholars interested in technology platforms in teaching. Educators can use these discoveries to establish effective educational strategies for the future of primary education in Vietnam, leveraging digital learning materials specifically and technological platforms in general.

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