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STRUCTURAL MODEL OF DIGITAL TRANSFORMATION READINESS OF INDONESIAN RURAL AND URBAN SCIENCE TEACHERS

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ABSTRACT

Technological and digital developments have implications for integrating technology into educational practice. As a result, teachers have to deal with digital transformation. This research aims to compare the digital transformation readiness of science teachers in urban and rural areas. This research compares to the previously determined structural model of digital transformation readiness. This research used a survey method to test several research hypotheses. The respondents of this research were 206 science teachers in Indonesia, selected using stratified random sampling to ensure a balanced representation of various sub-groups such as gender, geographic location, island, age, type and status of institution, and teaching experience. This research data was analyzed using AMOS 26 to analyze CBSEM. The research results show three main points in digital transformation: the self-efficacy of rural teachers is affected by digital literacy, the information empowerment of rural teachers is affected by information literacy and digital literacy, and the information use of rural teachers is affected by information culture. Urban teachers at these three points are more dependent and require recommendations for development and optimization. The conclusion of this research leads to a recommendation that, in general, teachers in rural areas still need improvements, while teachers in urban areas are already moving towards developing and sustaining their skills.

Keywords: digital transformation; rural; science teacher; structural model; urban

INTRODUCTION

Technological advancement presents a significant challenge in today's rapidly evolving educational landscape (Akour & Alenezi, 2022). The skills students acquire in school are at risk of becoming obsolete quickly, necessitating a fundamental shift in how education integrates technology (Park & Kim, 2020). This integration must transcend the mere incorporation of digital tools and lead toward fostering innovative, collaborative, and interdisciplinary learning experiences (Herring et al., 2016; Bond et al., 2018; Oliver & Jorre, 2018; Luo et al., 2021). The core issue lies in the digital transformation of education, which demands that educators predict and impart the competencies required for future success. Unlike the traditional approach focusing on reactive competencies, digital transformation emphasizes the need for proactive, non-cognitive competencies, commonly called digital competencies (Goulart et al., 2022). This shift is challenging, requiring a forward-looking educational framework that prepares students for future demands.

A pivotal element of this transformation is the role of teachers. They are expected to not only integrate digital tools into their instruction but also to function as designers, mentors, facilitators, and evaluators within this new educational paradigm (Wang et al., 2018). Teachers must be skilled in cultivating a digital information culture, effectively guiding students to use digital

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technology within contemporary cultural contexts (Akour & Alenezi, 2022). Deja et al. (2021) identify several key variables essential to digital transformation: information management, information use, information culture, information empowerment, information literacy, digital literacy, and self-efficacy (see Figure 1).

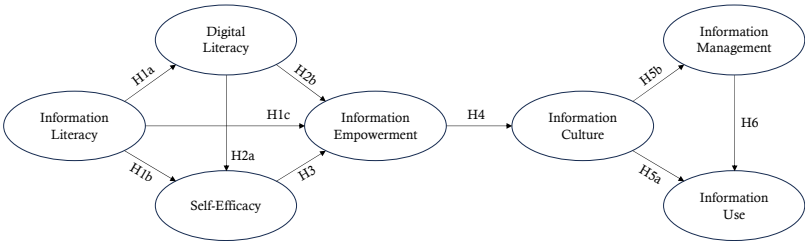


Figure 1. The Concept of Digital Transformation (Deja et al., 2021)

This research aims to create a structural model of digital transformation readiness for science teachers in rural and urban areas in Indonesia. Thus, this comparative research compares the structural model of digital transformation readiness of science teachers in rural and urban areas. The final structural model can provide an overview of the differences in variables or factors determining the digital transformation readiness of science teachers in rural and urban areas in Indonesia.

Based on KOMINFO data (2022), the digital literacy index of Indonesian society has increased in 2022 compared to 2021 in three pillars of digital skills: digital skills, digital ethics, and digital safety. However, the index experienced a decline in the digital culture pillar from 3.90 (2021) to 3.84 (2022). The results of the digital literacy index give rise to further questions. Indonesian society, in general, has experienced an increase in the pillars of digital skills, ethics, and safety, but why has it experienced a decline in culture? This question is discussed in this research.

Furthermore, a strong reason why this research is necessary is that the previous KOMINFO data (2022) presents general digital literacy index data even though it has data on the education segment. The results of this research can provide insight or a new perspective in the form of a description of digital literacy in urban and rural areas in the educational aspect, specifically regarding human resources, such as teachers.

Besides, if the comparison of the digital transformation of urban and rural areas is explored more deeply, it will give rise to an interesting discourse from a social perspective. KOMINFO only compares the infrastructure, such as signal conditions, cellular operators, and regional conditions (Pangerapan, 2022). However, there are other aspects as social facts that can be explored, such as educational or family background (Marav, 2020), causes of inequality in skills (Bahri et al., 2022) and use of technology (Warschauer, 2004), motivation to use technology (Aggarwal, 2019), and others. This research is a recommendation from Deja et al. (2021). However, Deja et al. (2021) focus more on the digital transformation readiness of librarians. In contrast, this research focuses on the readiness for digital transformation of science teachers, specifically comparing urban and rural areas. Research on the structural model of digital transformation readiness is necessary for two other important reasons. First, the teacher is the central figure in learning practice. Therefore, teachers must be adaptive to current developments. Second, mapping digital transformation readiness will be the basis for providing appropriate and comprehensive treatment for teachers in this digital transformation era, both in urban and rural areas.

As mentioned, this research is based on Deja et al. (2021) to portray the digital transformation readiness of science teachers in urban and rural areas. In more detail, Deja et al. (2021) mention the following digital transformation variables: (1) Information Management (IM) or the ability to search, organize, access, and disseminate information well (Detlor, 2010), (2) Information Use (IU) or the ability to process information and use that information purposefully (Popovič et al., 2014), (3) Information Culture (IC) or behaviors, norms, and values in an information system about how information should be obtained and used (Choo, 2013), (4) Information Empowerment (IE) or a critical attitude towards the surrounding environment by using information (Maiorano et al., 2021), (5) Information Literacy (IL) or the ability to search, select and evaluate information specifically aimed at solving problems (Limberg et al., 2012), (6) Digital Literacy (DL) or the ability to find and handle digital information (Lankshear & Knobel, 2008), and (7) Self-Efficacy (SE) or one's beliefs that influence actions, tasks, and goals (Bandura et al., 1999).

Deja et al. (2021) assume the seven variables have a relationship. This relationship then

forms a structural model, as shown in Figure 1. This structural model then becomes a guide for this research to compare the digital transformation readiness of urban and rural science teachers. Based on this structural model, the following are the details of the research hypothesis:

H1a: IL affects DL

H1b: IL affects SE

H1c: IL affects IE

Several studies prove that IL is specifically related to DL (H1a) (Mackey & Jacobson, 2017). IL is a need to create information-sharing activities, including sharing in an online environment (DL). In addition, IL has a relationship with SE (H1b) (Ahmad et al., 2020). Someone with information literacy skills is likelier to become more aware and critical of information (Mahmood, 2016).

H2a: DL affects SE

H2b: DL affects IE

Islami (2019) explains that DL has a broad impact, but specifically, DL can influence behavior (SE) (H2a). Likewise, with the empowerment aspect, someone with good digital literacy (DL) quality has a higher possibility of empowering themselves with information (H2b) (Shopova, 2014).

H3: SE affects IE

H4: IE affects IC

SE is defined as a solid motivational construct. Huang et al. (2020) state that SE is closely related to educational outcomes, such as academic performance and the influence of anxiety. Furthermore, strengthening information empowerment can rely on self-efficacy (Huang et al., 2020). Someone with good information empowerment (IE) abilities can synergize with the ability to build organizational communication systems (IC) (Choo, 2013).

H5a: IC affects IU

H5b: IC affects IM

H6: IM affects IU

IC specifically has a positive effect on IU and IM. Abrahamson and Goodman-Delahunty (2013) state that someone with an excellent information culture can use information well even though it does not fully guarantee that they will have information management at the same time. Furthermore, good IM can undoubtedly increase the possibility of using information well.

As a guide to capturing the digital transformation readiness of urban and rural science teachers, an instrument is adopted from the results of Deja et al. (2021), as shown in Table 1.

Table 1. Instrument of Digital Transformation Readiness

No	Variable	Indicator
1	Information Management (IM)	My school has formal procedures for sharing knowledge. My school has a culture that promotes knowledge and sharing information. My school encourages sharing the latest information, especially renewable research results.
2	Information Use (IU)	Sharing information and knowledge is very important for the development of my abilities. My school always recommends that teachers refer to the latest research in the learning process. My school always suggests that teachers refer to relevant research results or information to solve problems.
3	Information Culture (IC)	My school teachers are used to keeping abreast of relevant information or the latest research results. My school teachers are used to sharing information. My school teachers are used to holding discussions on renewable research topics.
4	Information Empowerment (IE)	I am used to using information to build new ideas. I am used to using information or research results as a basis for discussions. I am used to updating my views based on discussions with fellow teachers.
5	Information Literacy (IL)	I determine where and how to find the information I need. I use various sources (books, magazines, scientific articles, and the like) to find information. I select and evaluate the information that best suits my needs.
6	Digital Literacy (DL)	I can use digital technology to search for or share information. I am used to collaborating with fellow teachers using digital technology. I often utilize digital technology to analyze information.
7	Self-Efficacy (SE)	I believe that digital technology can help complete tasks effectively. I believe that digital technology can improve skills. I believe that digital technology can help in information analysis.

METHODS

This research used a survey method to compare the digital transformation readiness of teachers in urban and rural areas in Indonesia. The survey method was used because teachers carried out self-report measures (Zhang et al., 2017) regarding their digital transformation readiness based on the indicators in the research instrument. The respondents for this research were 206 science teachers in Indonesia. Respondents were selected using stratified random sampling (Latpate, 2020) to ensure a balanced representation of various sub-groups such as gender, geographic location, island, age, type and status of institution, and teaching experience.

The population was divided into distinct strata based on the mentioned sub-groups to implement stratified random sampling. Within each stratum, respondents were randomly selected to ensure each subgroup was adequately represented, enhancing the generalizability of the findings. This technique minimizes sampling bias and ensures that diverse perspectives are included.

To ensure the relevance of respondent selection to the research theme, respondent data was verified based on inclusion and exclusion criteria. The inclusion criteria encompass science teachers who teach in urban or rural areas in Indonesia, work under the Ministry of Religious Affairs or the Ministry of Education and Culture, and are from public or private institutions across various educational levels. Their teaching experience should also range from less than 5 to more than 40 years. On the other hand, the exclusion criteria include teachers who teach subjects other than science, those from institutions outside the relevant ministries, or those whose institutional status is unclear. The detailed composition of science teacher respondents is presented in Table 2.

Table 2. The Demography of Respondents (N = 206)

	N	%
Gender		
Male	64	31%
Female	142	69%
Rural/Urban		
Rural	123	60%
Urban	83	40%
Island		
Java	95	46%
Kalimantan	20	10%
Maluku	11	5%
Nusa Tenggara & Bali	12	6%
Papua	12	6%
Sulawesi	6	3%
Sumatera	50	24%
Age		
25 - 35	68	33%
35 - 44	79	38%
45 - 54	44	21%
55 - 64	15	7%
Institution		
Ministry of Religious Affairs	111	54%
Ministry of Education and Culture	95	46%
Institution Status		
Public	125	61%
Private	81	39%
Institution Level		
Elementary/MI	6	3%
Junior High/MTs	127	62%
Senior High/MA	70	34%
Vocational High/Equivalent	3	1%
Teaching Experience		
< 5 years	38	18%
< 10 years	51	25%
< 20 years	93	45%
< 30 years	21	10%
< 40 years	1	0%
> 40 years	2	1%

The first stage of this research was to develop a digital transformation readiness instrument (Table 1). Instrument refers to Deja et al. (2021) with several adjustments according to the context of this research. The second stage was a survey using Google Forms as a data collection technique. The third stage was survey data analysis using frequency table analysis, histogram analysis, and CBSEM.

Frequency table analysis provides a straightforward summary of calculations for survey data collected and is a starting point for interpreting the data (Cooksey, 2020). In the context of this research, this analysis technique was used to summarize survey data on each variable based on classifications of gender, location (rural or urban), age, institution type, or institution level. Furthermore, this analysis technique led to an overview of the comparison of average achievements based on the classifications mentioned and the strengths and weaknesses of the emerging digital transformation readiness variables.

The histogram analysis technique had almost the same function as frequency analysis: summarizing data. However, the advantages of histograms are that they visualize the data distribution for each research variable and a continuous summary of data frequencies (Kirk, 2019). Therefore, this analysis technique provides a visual comparison of the distribution of data on each variable of digital transformation readiness for teachers in rural and urban areas.

The final data analysis in this study used AMOS 26 for CBSEM. The CBSEM procedure is appropriate for measuring the influence of indicators on a concept. CBSEM is a general factor-based procedure that considers constructs as factors that explain covariation between related indicators (Sarstedt et al., 2016). This means that CBSEM is used to analyze and compare factors that have the most effect on each digital transformation readiness variable of teachers in rural and urban areas.

RESULTS AND DISCUSSION

The research results begin with a comparison display of the average achievements of each variable based on the respondent's demographics. The starting point for this research is social structure: rural and urban. Therefore, the comparison of average achievements is presented from a sociological perspective. Table 3 explains the strengths and weaknesses of variables based on gender, where the average achievement of female teachers is always higher than that of male teachers. Meanwhile, from the social structure perspective, the average achievement of teachers in urban areas is always higher than in rural areas.

Table 3. Average Achievement of Digital Transformation Readiness Indicators Based on Social Structure and Gender

Social Structure	Information management		Information Use		Information Culture		Information Empowerment		Information Literacy		Digital Literacy		Self-efficacy		Average
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	
Rural	4,13	4,27	3,95	4,00	3,86	3,94	4,00	4,06	4,18	4,24	4,07	4,13	4,35	4,41	**4,11**
Urban	4,42	4,62	4,00	4,42	4,08	4,34	4,15	4,43	4,35	4,51	4,40	4,34	4,67	4,62	**4,38**
Average	4,28	4,45	3,98	4,21	3,97	4,14	4,08	4,25	4,27	4,38	4,24	4,24	4,51	4,52	

The highest average achievement for male teachers in rural areas is self-efficacy (4.35), and the lowest is information culture (3.86). In comparison, in urban areas, the highest achievement for male teachers is self-efficacy (4.67), and the lowest is the use of information (4.00). This result is interesting because it turns out that the weakness of male science teachers in rural areas is information culture, while the weakness of male science teachers in urban areas is information use.

The highest average achievement for female teachers in rural areas is self-efficacy (4.41), and the lowest is information culture (3.94). Meanwhile, in urban areas, the highest achievement for female teachers is information management (4.62), and the lowest is information culture (4.34). Thus, the weakness of female science teachers in rural and urban areas is information culture. Even so, female science teachers in rural areas have self-efficacy, and female teachers in urban areas have information management.

However, there is an anomaly in these results, which shows that female teachers in urban areas have strength in information management, even though the strength of other teachers always leads to self-efficacy (see Table 4). This anomaly shows that female teachers in urban areas have high quality, especially in the context of digital

transformation readiness. This high quality can be attributed to several key factors. Firstly, urban areas generally provide better access to technology and digital resources, including high-speed internet, advanced hardware, and a variety of educational software, which are crucial for developing digital competencies (Muhaimin et al., 2020). This access allows female teachers to engage more frequently and effectively with digital tools, enhancing their skills in information management.

Secondly, urban schools often offer more professional development opportunities (Rahman, 2022), such as workshops, seminars, and training programs focused on integrating technology into the classroom. These opportunities enable female teachers to stay updated with the latest educational technologies and teaching methodologies, further improving their digital literacy and competence. Additionally, the supportive social and cultural environment in urban areas plays a significant role. Urban settings typically have higher awareness and acceptance of digital literacy's importance (Pratolo & Solikhati, 2020), encouraging female teachers to pursue technological proficiency actively. The presence of professional networks and communities in urban also provides platforms for female teachers to share best practices and gain insights from their peers, fostering a collaborative learning atmosphere. Lastly, the practical application of technology in everyday teaching activities in urban schools helps female teachers gain hands-on experience, thereby boosting their confidence and self-efficacy in using digital tools.

This combination of better access to resources, continuous professional development, a supportive environment, and practical experience contributes to the higher quality of female teachers in urban areas regarding digital transformation readiness. On the other hand, implicitly, the distribution of competence of teachers in urban areas, both male and female, tends to be even. The even distribution of these competencies can also be proven by the self-efficacy of female teachers in urban areas, which is as high as that of information management (4.62). Several studies also reveal that female teachers are superior to male teachers in pedagogy (Topchyan & Woehler, 2020), especially in information and communication technology parameters (Kumar & Sri, 2023).

These results have significant implications for educational policy and teaching practices, particularly in developing gender-responsive digital transformation in the context of science teachers in rural and urban areas. Policymakers should implement targeted professional development programs that address the specific needs of male and female science teachers in both rural and urban settings. For example, training for male teachers in rural areas should focus on enhancing information culture, while training for male teachers in urban areas should emphasize information utilization.

Educational policies should adopt a gender-sensitive approach that recognizes and addresses the unique challenges male and female teachers face. For instance, programs encouraging female science teachers in rural areas to participate in professional networks and provide mentorship programs are urgently needed to enhance their information culture and digital readiness. This gender-sensitive approach is still relatively underexplored in research findings. While gender-sensitive approaches are commonly employed to intervene with students (Xiong et al., 2020; Lesperance et al., 2022; Luyckx et al., 2023), it is rare to see this approach implemented with teachers to foster their professional development.

Furthermore, future research should delve deeper into the factors contributing to the differences in digital transformation readiness between male and female science teachers in rural and urban areas. Conducting longitudinal studies to track the development of digital competencies over time can provide insights into the effectiveness of professional development programs and resource allocation. Comparative studies involving teachers from various regions or countries can help identify best practices and strategies that can be adapted to the Indonesian context. Utilizing qualitative research methods, such as interviews and focus groups, can reveal personal experiences and challenges faced by teachers, offering a more nuanced understanding of the factors influencing digital readiness.

Table 4. Strength and Weakness of Variables Based on Social Structure and Gender

Rural/ Urban	Strength (S) and Weakness (W)	
	M	F
Rural	Self-efficacy (S), Information culture (W)	Self-efficacy (S), Information culture (W)
Urban	Self-efficacy (S), Information use (W)	Information management (S), Information culture (W)

The following result compares the average achievement of each variable based on age. This comparison is also based on a sociological perspective: teachers in rural and urban areas.

Based on Table 5, the highest average achievement for teachers in rural areas is at the age of 55 – 64 (4.21), with information management as the highest average achievement (4.75). Meanwhile, the highest average achievement for teachers in urban areas is also at ages 55 - 64 (4.58), with self-efficacy as the highest average (4.82). Meanwhile, young teachers (25 – 35), whether in rural or urban areas, have strong self-efficacy but are weak in information culture (R: 3,97, U: 4,22).

These results indicate that older science teachers, particularly those aged 55-64, tend to have higher overall digital transformation readiness than their younger counterparts. This can be attributed to their extensive teaching experience (Scherer et al., 2023), which has provided them with more opportunities to integrate and manage digital information effectively. The higher self-efficacy observed among older teachers in urban areas, in particular, underscores their confidence and ability to adapt to technological advancements due to better access to continuous professional development and technological resources (Aroca et al., 2023).

For science teachers aged 25-35 in rural and urban areas, strong self-efficacy reflects a high confidence level in their ability to use digital devices and integrate technology into their teaching (see Table 6). However, their weaker information culture reveals challenges in effectively utilizing digital information and fostering an environment where information is managed and shared appropriately (Artacho et al., 2020). This discrepancy arises from their limited professional experience, which has not provided sufficient opportunities to develop strong information culture practices. Additionally, younger teachers have had less exposure to professional development programs (Zheng, 2023) focused on information management than their older colleagues.

Table 5. Average Achievement of Digital Transformation Readiness Indicators Based on Social Structure and Age

Variable	Age							
	25 – 35		35 – 44		45 – 54		55 – 64	
	R	U	R	U	R	U	R	U
Information management	4,25	4,24	4,22	4,72	4,02	4,57	4,75	4,70
Information use	4,10	4,24	3,88	4,34	3,89	4,29	4,17	4,42
Information culture	3,97	4,22	3,82	4,36	3,91	4,11	4,33	4,55
Information empowerment	4,09	4,33	3,98	4,43	4,07	4,28	4,00	4,39
Information literacy	4,31	4,45	4,14	4,53	4,19	4,36	4,17	4,61
Digital literacy	4,20	4,41	4,05	4,36	4,02	4,23	4,00	4,55
Self-efficacy	4,44	4,55	4,36	4,67	4,39	4,56	4,08	4,82
Average	4,19	4,35	4,06	4,49	4,07	4,34	4,21	4,58

Science teachers in the 35-44 age group, who exhibit moderate levels of self-efficacy and information culture, represent a transitional phase in their careers. These teachers are building upon their early experiences and professional development, enabling them to integrate technology into their teaching effectively (Wang et al., 2023). However, they still face challenges in fully developing a strong information culture. This age group is crucial for targeted interventions, as they are at a point where further professional development can significantly enhance their digital competencies, particularly in information management and culture.

Science teachers aged 45-54 demonstrate increased competence in self-efficacy and information culture, reflecting their substantial teaching experience and participation in professional development over the years. This age group benefits from a blend of experience and ongoing learning, enabling them to integrate digital tools and manage digital information effectively. The data suggest that this group is approaching the peak of their digital readiness, making them valuable resources for mentoring younger teachers and sharing best practices in digital transformation.

This research offers a distinctive advantage by providing a detailed analysis of science teachers' digital transformation readiness across specific age ranges in rural and urban areas. Unlike previous research, which typically categorizes teachers into broad age groups such as young (Volkov & Chikarova, 2021), middle-aged or older adults (Bulbul et al., 2022; Vonitsanos et al., 2024), this research delves into the nuances within these categories. By examining distinct age

ranges, such as 25-35, 35-44, 45-54, and 55-64, the research uncovers detailed insights into the strengths and weaknesses of teachers at different stages of their careers. This granularity enables a more precise understanding of how age and geographical context influence digital transformation readiness, highlighting variations that broader categorizations might overlook.

Explicitly, this research offers a unique contribution through a comparative analysis of rural and urban environments based on specific age ranges. In other words, the results of this study indicate that teachers' readiness for digital transformation can vary significantly based on two variables: geographical location and age range. Based on these two variables, policymakers should consider targeted interventions for teacher development, whether they are science or non-science teachers, based on these two variables. Similarly, further research should explore the polarization of teacher characteristics based on specific age ranges and geographical locations, as this presents a compelling study area.

Table 6. Strength and Weakness of Variables Based on Social Structure and Age

Social Structure	Age			
	25 – 35	**35 – 44**	**45 – 54**	**55 – 64**
Rural	Self-efficacy (S), Information culture (W)	Self-efficacy (S), Information culture (W)	Self-efficacy (S), Information use (W)	Information management (S), Information empowerment (W)
Urban	Self-efficacy (S), Information culture (W)	Information management (S), Information use(W)	Information management (S), Information culture (W)	Self-efficacy (S), Information empowerment (W)

Apart from that, this research also highlights how the average achievement of each variable compares based on institutions: Ministry of Religious Affairs or Ministry of Education and Culture. It is interesting to explore because it is a classic problem of educational dualism in Indonesia. There has been much research discussing this but the discussion tends to focus on challenges (Wibowo et al., 2022), point of view, curriculum (Halim, 2022), or effectiveness (Rahmawati & Rodiyah, 2023).

Although not much different, the average achievement of teachers in the Ministry of Education and Culture is always higher for each digital transformation readiness variable (see Table 7). The highest average achievement for teachers in the Ministry of Education and Culture is 4.59 on self-efficacy, while the lowest is 4.10 on information culture. Teachers in the Ministry of Religious Affairs also achieve the highest average on self-efficacy (4.45) and the lowest on information culture (4.09). Thus, teachers in the Ministry of Religious Affairs and the Ministry of Education and Culture are equally strong in self-efficacy and weak in information culture.

This analysis suggests that both groups of science teachers, whether from the Ministry of Education and Culture or the Ministry of Religious Affairs, have strong confidence (self-efficacy) in their ability to effectively integrate and utilize digital tools, a crucial component of digital transformation readiness. However, the consistently emerging weakness among science teachers is in the area of information culture. Information culture encompasses the practices, attitudes, and values of managing and utilizing information within an organization (Choo, 2013). The low scores in this area imply that teachers may struggle with sharing, managing, and applying information effectively, which can hinder the overall digital transformation process. This shortcoming may stem from inadequate training, resources, or institutional support related to information management (Lomachinska & Lomachinskyi, 2021).

Regarding educational policy implications, policymakers must tackle this issue by developing targeted professional development programs focused on enhancing information culture. Such programs aim to improve teachers' skills in managing digital information, foster a culture of collaboration, and promote effective use of information. In terms of teaching practices, schools should prioritize creating environments that support a strong information culture. This could include providing access to digital resources, encouraging collaborative projects that require effective information management, and integrating information literacy into the curriculum. By fostering a robust information culture, schools can ensure that teachers are better equipped to meet the demands of digital transformation. Future research should investigate the underlying reasons for the differences in information culture between teachers from both ministries and whether similar patterns exist in different educational contexts.

Table 7. Average Achievement of Digital Transformation Readiness Indicators Based on Social Structure and Institution

Rural/ Urban	Information management		Information use		Information culture		Information empowerment		Information literacy		Digital literacy		Self-efficacy		Average
	RA	EC	RA	EC	RA	EC	RA	EC	RA	EC	RA	EC	RA	EC	
Rural	4,17	4,25	3,90	4,09	3,83	4,00	3,93	4,16	4,16	4,30	4,02	4,20	4,29	4,51	**4,13**
Urban	4,61	4,60	4,33	4,31	4,34	4,20	4,43	4,28	4,44	4,51	4,27	4,45	4,60	4,67	**4,43**
Average	**4,39**	**4,43**	**4,12**	**4,20**	**4,09**	**4,10**	**4,18**	4,22	4,30	4,41	4,15	4,33	4,45	4,59	

A result that is no less interesting is the comparison of the averages of each variable based on institutional status: public and private (see Table 8). Many studies have tried to compare these two types of institutions, such as on efficiency (Johnes & Virmani, 2020), socio-economics (Suna et al., 2020), or teachers' competencies (Fayyaz et al., 2021). However, this research compares institutional status from a sociological, urban, and rural perspective, although only with simple descriptive statistics.

Based on the results, the average achievement of public school teachers in rural areas is always superior to that of private school teachers. On the other hand, the average achievement of private school teachers in urban areas outperforms that of public school teachers. Those variables are information management and digital literacy. Unsurprisingly, private elite schools in Indonesia are becoming popular and trending (Ihsan, 2022; Pastiwi & Ihsan, 2023). These elite private schools provide facilities and teachers of excellent and decent quality (Riksa, 2023).

The interesting thing about this finding is the anomaly of private schools in urban areas outperforming public schools. Of the 206 respondents, 125 respondents came from public schools, and 81 came from private schools. In more detail, respondents from urban areas consisted of 57 public school teachers and 26 private school teachers. This means that the results state that teachers in private schools are superior to public schools, consisting of 83 respondents. This composition is unbalanced from the perspective of the number of respondents, where there are half as many public teachers in urban areas as private teachers. This research is also limited to a sociological portrait of rural and urban areas and does not examine the specific comparison of public and private schools. Therefore, this anomaly can be a recommendation for further research.

Table 8. Average Achievement of Digital Transformation Readiness Indicators Based on Social Structure and Institution Status

Rural/ Urban	Information management		Information use		Information culture		Information empowerment		Information literacy		Digital literacy		Self-efficacy		Average
	PU	PR	PU	PR	PU	PR	PU	PR	PU	PR	PU	PR	PU	PR	
Rural	4,25	4,18	4,09	3,85	3,93	3,88	4,16	3,90	4,27	4,16	4,19	4,00	4,55	4,19	4,11
Urban	4,56	4,60	4,32	4,32	4,21	4,42	4,37	4,35	4,46	4,51	4,29	4,49	4,64	4,60	4,44
Average	4,41	4,39	4,21	4,09	4,07	4,15	4,27	4,13	4,37	4,34	4,24	4,25	4,60	4,40	

Overall, teachers in urban and rural areas, both public and private, both show self-efficacy as the most prominent among other variables (see Table 9). The superiority of self-efficacy does not only occur from the perspective of institutional status but also occurs from the perspective of gender (see Table 4), age (see Table 6), and institution (see Table 7). This strength of self-efficacy is sometimes followed by information management. Furthermore, information culture is quite consistently the weakest among the other variables. This variable is occasionally followed by information use, which often appears weakest.

Table 9. Strength and Weakness Based on Social Structure and Institution Status

Rural/ Urban	Strength (S) and Weakness (W)	
	Public	Private
Rural	Self-efficacy (S), Information culture (W)	Self-efficacy (S), Information use (W)
Urban	Self-efficacy (S), Information culture (W)	Information management (S), Information use (W)

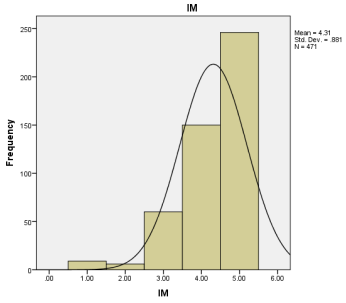
The assumption is that self-efficacy and information management are determining variables that can become central points in building digital transformation readiness for teachers in urban and rural areas. Likewise, information culture and information use are variables that must be the focus for development in the future. This assumption certainly needs to be tested first. Next, Table 10 compares the average achievement of variables in general and their standard deviations.

Table 10. Average Achievement of Each Variable Based on Social Structure

Variable	Average		Standard Deviation	
	Rural	Urban	Rural	Urban
Information Management	4.31	4.61	0.881	0.758
Information Use	4.10	4.34	0.844	0.845
Information Culture	3.96	4.32	0.900	0.836
Information Empowerment	4.10	4.33	0.839	0.754
Information Literacy	4.18	4.49	0.823	0.747
Digital Literacy	4.10	4.45	0.825	0.782
Self-Efficacy	4.33	4.62	0.794	0.669

Next is a comparative analysis through histogram visualization, which provides an overview of the data distribution for each variable based on sociological classification: teachers in rural and urban areas.

Rural



Urban

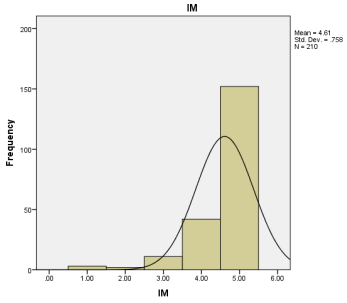
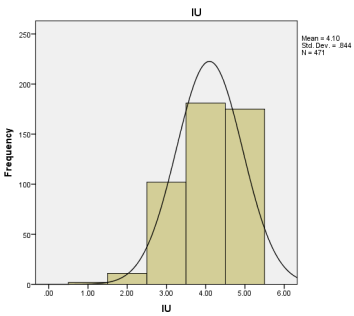


Figure 2. Histogram Visualization of Information Management Comparison Between Teachers in Urban and Rural Areas

Histogram comparison shows that teachers in urban areas are better prepared than teachers in rural areas regarding information management. Teachers in urban areas have achieved a higher average score for information management (4.61) than rural teachers (4.31). Information management has the following indicators: knowledge sharing, discussion, and adequate school facilities. Teachers in rural areas are weak on the last indicator, the lack of adequate facilities from schools to access information (mean = 4.21). In urban areas, it is the opposite; teachers get more adequate facilities to access information (mean = 4.59). Apart from that, teachers in urban areas are also highly aware of sharing information with other teachers (mean = 4.66).

Rural



Urban

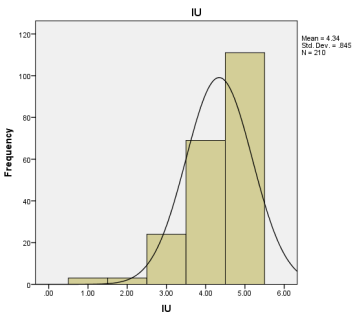


Figure 3. Histogram Visualization of Information Use Comparison Between Teachers in Urban and Rural Areas

The following are indicators of information use: (1) schools encourage teachers to use research results to be implemented in learning, (2) teachers are used to using information to develop skills, and (3) teachers are used to using information/research results to solve problems in learning. Schools in rural areas lack a culture that encourages teachers to use research results to apply them in learning (4.01). As a result, teachers are less accustomed to using research results to solve problems in learning (4.03). Meanwhile, teachers in urban areas consistently use information or research results to develop their abilities (mean = 4.52). This condition makes sense because urban schools encourage teachers to apply research results in learning.

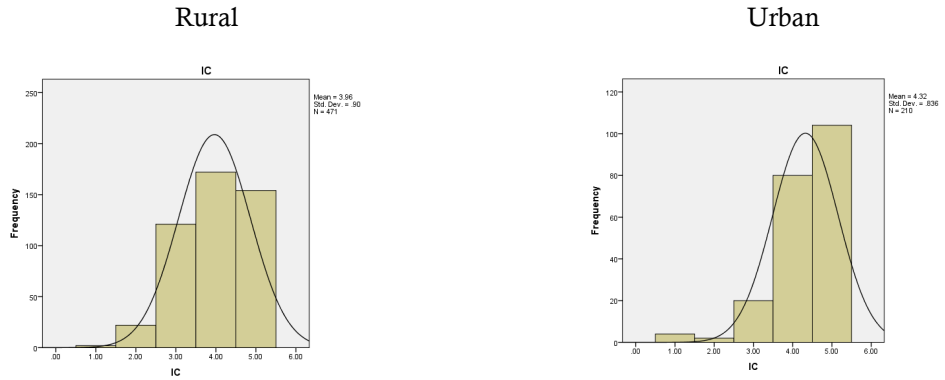


Figure 4. Histogram Visualization of Information Culture Comparison Between Teachers in Urban and Rural Areas

The research results show that teachers in rural areas do not follow developments in information or research results (3.94) and are less accustomed to using technology to carry out productive communication related to knowledge development (3.98). These habits are clearly in line with the previous information use variable. Teachers in rural areas receive less cultural encouragement from schools to utilize research results. Meanwhile, teachers in urban areas actively use digital technology to communicate productively regarding knowledge development (4.47) and share it with fellow teachers (4.31).

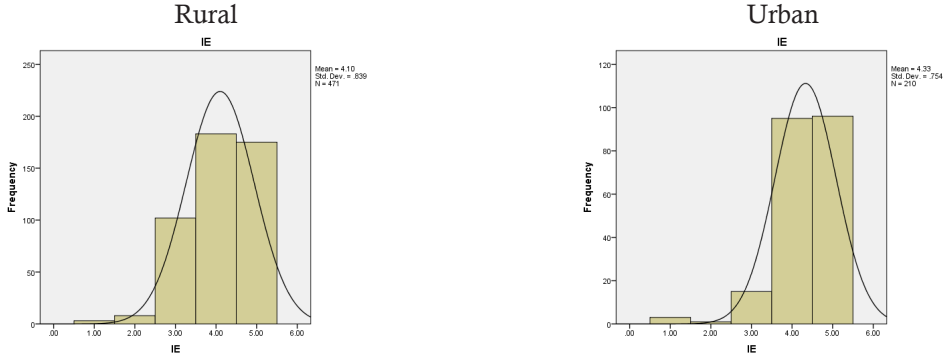


Figure 5. Histogram Visualization of Information Empowerment Comparison Between Teachers in Urban and Rural Areas

Information empowerment has several indicators: (1) teachers find out how to use information in new ways, (2) teachers are used to using information or research results as a basis for discussions, and (3) teachers are used to updating their views on something based on the results of discussions with fellow teachers.

The research results show that teachers in rural areas are still less accustomed to using information or research results as a basis for discussions (4.02). This result aligns with two previous findings on information use (IU) and information culture (IC). Teachers in urban areas are different. They can update their views on something based on the discussions with fellow teachers (4.41). Of course, the view is updated based on information from research results (4.24) and creativity to process information in new ways (4.34).

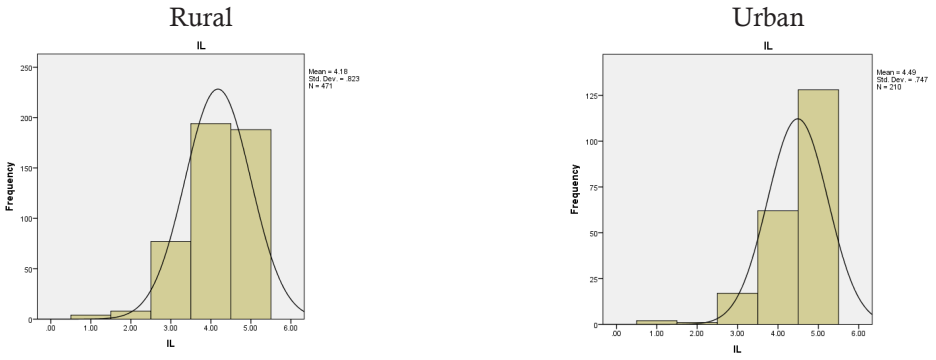


Figure 6. Histogram Visualization of Information Literacy Comparison Between Teachers in Urban and Rural Areas

Information literacy refers to several indicators: (1) teachers can determine where and how to find the information they need through digital channels, (2) teachers use various sources (books, magazines, scientific articles, and the like) to search for information, and (3) teachers select and evaluate the information that best suits their needs.

The key to teachers' readiness for digital transformation lies in this variable. However, teachers in rural areas are in almost the same condition based on the three IL indicators. Teachers in rural areas have not been able to determine the information needed, have not been able to determine the type of sources for gathering information, and have also not been able to choose and evaluate the information that best suits their needs. Meanwhile, teachers in urban areas have performed well on these indicators (mean of all indicators = 4.50).

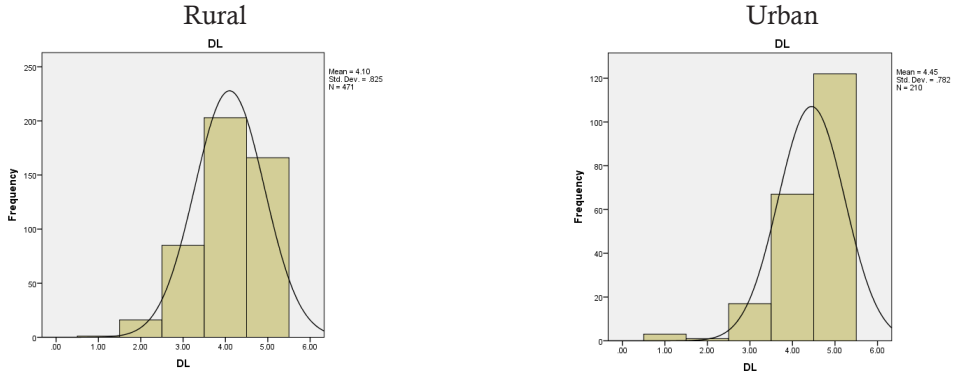


Figure 7. Histogram Visualization of Digital Literacy Comparison Between Teachers in Urban and Rural Areas

Digital literacy has several indicators: (1) teachers can use digital technology to search for or share information, (2) teachers are used to collaborating with fellow teachers using digital technology, and (3) teachers often use digital technology to analyze information. In the previous variable, teachers in rural areas do not maximize their habits of utilizing research results, and in digital literacy, it is not much different. Teachers in rural areas get the lowest average score on the second indicator, collaborating with fellow teachers using digital technology. They also still have minimal collaboration with fellow teachers (3.98).

Teachers in urban areas far outperform the average. They can use technology to search for or share information (4.52), are used to collaborate with fellow teachers using digital technology (4.35), and are used to using technology to analyze the information they get (4.45).

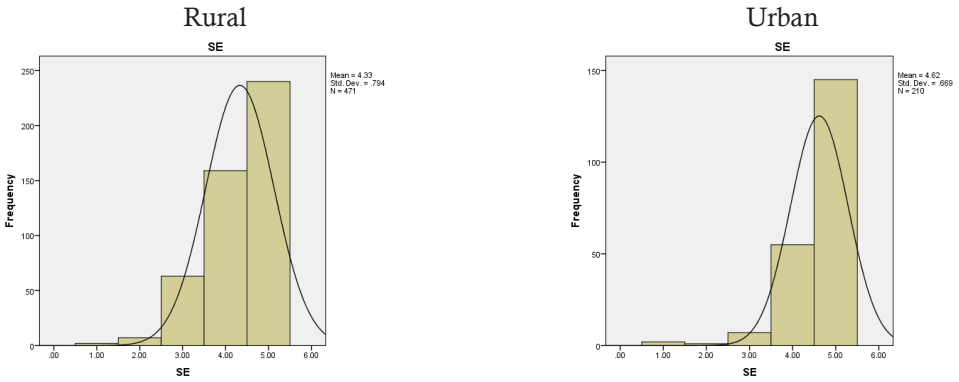


Figure 8. Histogram Visualization of Self-Efficacy Comparison Between Teachers in Urban and Rural Areas

The final variable is self-efficacy with the following indicators: (1) teachers believe that digital technology can help complete tasks effectively, (2) teachers believe that digital technology can help improve skills, and (3) teachers believe that digital technology can assist in information analysis.

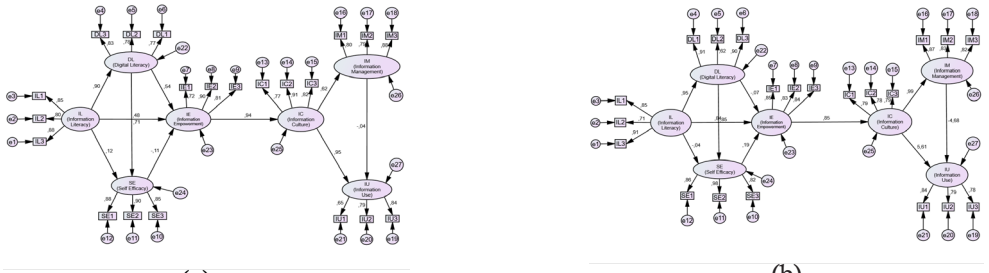
The results of this research are interesting. Teachers in rural areas have a strong belief that digital technology can help them complete tasks effectively (4.29), technology can improve their skills (4.38), and technology can help them analyze information (4.34). Self-efficacy is the variable with the highest average score of teachers in rural areas compared to other variables. It means that teachers in rural areas believe that digital technology can help them in many ways, but they have not shown the same thing in practical terms. This difference will be discussed further in this research.

An interesting result from this research concerns teachers in rural areas. They have pretty high self-efficacy (SE). In fact, the SE of teachers in rural areas gets the highest average score compared to other variables. This means that teachers in rural areas believe technology is essential to helping them solve learning problems. Unfortunately, this reasonably high SE is not accompanied by adequate facilities (IM) and school culture to implement research results in learning (IU). Simply put, teachers in rural areas already have internal capital (SE) to welcome digital transformation but lack external capital in school encouragement and facilities.

Regarding the low IM and IU, the most concrete proposed solution is that teachers are expected to be able to optimize SE within themselves to find other solutions and not depend on the environment and support of their school. In the context of this digital transformation, individuals with good SE should always express a positive attitude and immediately find a solution to the problems they face by utilizing technology (Sulistiani et al., 2024). In other words, teachers with high SE are the solution. They can become an inspiration for other teachers so they can build a good school culture. It is also hoped that this can slowly initiate and improve information use (IU) well in the future.

Several studies have specifically proposed several solutions to strengthen IM and IU. These solutions include digital literacy training (Rahmawati et al., 2024), focusing on developing school principal leadership to develop good school managerial and culture (Shaqura, 2024) or strengthening the teacher community (Popielarz, 2024). However, if teachers with high SE have to wait to realize such a solution, optimizing their belief in themselves as a quality of SE will be in vain. Therefore, even though weak IM and IU follow SE, this fact does not give the impression that digital transformation readiness is entirely negative. SE in this discussion point is the main capital point in digital transformation that needs to be optimized, while IM and IU are points that require attention to receive intervention.

Next, this research measures and builds a structural model to test the hypotheses, as shown in Figure 9.



(a) (b)

Figure 9. Structural Model Test of Theoretical Framework for Teachers in Rural (a) and Urban (b) Areas

Table 11 show the hypothesis test results for teachers in rural areas.

Table 11. Hypothesis Test Results for Teachers in Rural Areas

Hypothesis		Flow		CR.	P	Result
H1a	IL	→	DL	11,478	***	Accepted
H1b	IL	→	SE	,523	,601	Declined
H1c	DL	→	SE	3,005	,003	Accepted
H2a	IL	→	IE	2,572	,010	Accepted
H2b	DL	→	IE	2,385	,017	Accepted
H3	SE	→	IE	-1,023	,307	Declined
H4	IE	→	IC	9,010	***	Accepted
H5a	IC	→	IU	9,000	***	Accepted
H5b	IC	→	IM	6,741	***	Accepted
H6	IM	→	IU	-,517	,605	Declined

Table 12 show the hypothesis test results for teachers in urban areas.

Table 12. Hypothesis Test Results for Teachers in Urban Areas

Hypothesis		Flow		CR.	P	Result
H1a	IL	→	DL	10,122	***	Accepted
H1b	IL	→	SE	-,087	,931	Declined
H1c	DL	→	SE	1,801	,072	Declined
H2a	IL	→	IE	1,954	,051	Declined
H2b	DL	→	IE	-,151	,880	Declined
H3	SE	→	IE	1,304	,192	Declined
H4	IE	→	IC	6,762	***	Accepted
H5a	IC	→	IU	,333	***	Declined
H5b	IC	→	IM	8,097	***	Accepted
H6	IM	→	IU	-,278	,931	Declined

Based on the comparison of factorial analysis, several important notes can be concluded regarding hypotheses H1c (DL → SE), H2a (IL → IE), H2b (DL → IE), and H5a (IC → IU).

H1c (DL → SE)

Digital literacy significantly affects self-efficacy for teachers in rural areas but does not affect teachers in urban areas. These results show

that teachers in rural areas need digital literacy to support their self-efficacy. They also need better skills in using technology, collaborating using technology, and getting used to using technology in their daily lives.

These results confirm Widowati et al. (2023), showing that digital literacy can significantly affect self-efficacy. Likewise, Shonfeld et al. (2022) recommend a policy to develop digital literacy aspects to increase teachers' self-efficacy. Even more than that, Suryadi et al. (2024) emphasize that if digital literacy is well developed, it will significantly encourage the emergence of digital innovation in a person and foster digital leadership skills.

Another interesting thing is the self-efficacy of teachers in urban areas. What is the strengthening factor for the self-efficacy of urban teachers? The research results show that digital literacy does not affect teachers' self-efficacy in urban areas. Urban teachers' digital literacy is excellent. Teachers in urban areas can use technology to search for or share information, are accustomed to collaborating with fellow teachers using digital technology, and are accustomed to utilizing technology.

Roberts et al. (2001) show that in-service programs can increase teachers' self-efficacy. Apart from that, several studies explain that teachers' experience is the main factor in forming self-efficacy (Klassen & Chiu, 2010; Sandholtz & Ringstaff, 2014; Wang & Tsai, 2016; Ortan et al., 2021). Self-efficacy can increase through positive interactions between teachers (Hwang & Ham, 2021) and a good school climate (Zakariya, 2020), where teamwork between teachers has become a culture (An et al., 2024). This literature review is very much in line with the results of this study. Teachers in urban areas already have sufficient experience with digital literacy, a good climate at school, and positive interactions with fellow teachers.

Based on this description, the recommendation for teachers in rural areas is to strengthen digital literacy skills to support their self-efficacy. Meanwhile, teachers in urban areas with adequate digital literacy must enrich their insight and experience to strengthen their self-efficacy. Overall, whether for teachers in urban or rural areas, digital literacy needs to be developed in such a way as to lead to digital innovation and digital leadership, as recommended by Suryadi et al. (2024).

H2a (IL → IE) dan H2b (DL → IE)

Teachers in rural areas need information literacy and digital literacy to support their information empowerment. Meanwhile, teachers in urban areas are just the opposite. They no longer need information or digital literacy skills to increase information empowerment. Teachers in urban areas can update their views on something based on the results of discussions. Of course, their views are updated based on the information from research results and creativity to process information in new ways. Therefore, information empowerment for teachers in urban areas no longer depends on other variables; they already have it independently. Meanwhile, information and digital literacy are only supporting materials for implementing information empowerment.

What do teachers in urban areas need to maintain this information empowerment simultaneously? Some have recommended strengthening habits to keep up with developments in digital information (Eraku et al., 2021) and developing school policies to ensure this information empowerment continues (Singh & Banga, 2022). Schools must start thinking about strengthening the role of libraries to increase information empowerment (Habibinejad & Khoini, 2021; Oladokun et al., 2021; Isabella et al., 2022), or through the school authority itself to form a community that focuses explicitly on activities with academic engagement (Calafell et al., 2024). Meanwhile, the option for teachers in rural areas is to strengthen information literacy and digital literacy to encourage their information empowerment.

H5a (IC → IU)

Teachers in urban areas already use information well. They can consistently use information or research results to improve their skills, including using research results to develop learning and solve learning problems. Thus, teachers in urban areas need other variables besides information culture to continue encouraging this ability.

Boylu and Çevik (2022) state that good information use skills are always closely related to two other abilities: processing research and focusing on a particular academic study. In other words, if teachers can use information to conduct further research with specific academic study tendencies, information use will become stronger. Apart from that, an interesting review by Bruce and Hughes (2010) states that information use will be more substantial if teachers' actions are more directed towards information use for learning. In a digital context, teachers can apply the learning setting to a flipped classroom to optimize information use for themselves and their students simultaneously (Amine et al., 2024). Specifically, teachers must always provide valuable information for the continuous development of their learning. More specifically, Haliso and Laja-Ademol

(2013) suggest that librarians ensure the availability of timely, relevant, and up-to-date information sources with modern information technology facilities for teachers so that their academic productivity can be better.

What about teachers in rural areas? Information culture must be the starting point for increasing their information use. At the very least, teachers in rural areas must get used to following developments in information or research results and utilizing technology for productive activities related to developing their knowledge. Schools in rural areas must also have a positive atmosphere through cultural encouragement towards teachers.

CONCLUSION

This research highlights significant differences in digital transformation readiness between science teachers in urban and rural areas of Indonesia. The findings indicate that digital literacy (DL) is crucial for enhancing self-efficacy (SE) among rural teachers, whereas urban teachers already possess high levels of self-efficacy independent of digital literacy. Additionally, information literacy (IL) and digital literacy significantly contribute to information empowerment (IE) among rural teachers, while the information culture (IC) within rural schools plays a critical role in influencing teachers' information use (IU). These results suggest that rural teachers require targeted professional development programs to improve their digital literacy and foster supportive information cultures within their schools.

The impact of this research is significant as it underscores the need for context-specific professional development strategies to address the digital transformation readiness gap between urban and rural teachers. Implementing these strategies can enhance the quality of education in rural areas by empowering teachers with the necessary digital skills and support. For urban areas, efforts should aim to sustain and expand access to advanced digital tools and continuous professional growth opportunities. By addressing these disparities, this research provides a pathway for policymakers and educators to foster equitable educational outcomes across diverse settings in Indonesia, ultimately improving the national educational system.

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