Utilization of information and communication technology (ICT) in improving the performance of agricultural extension workers and disaster management in Agam Regency, West Sumatra Province

Basril Basyar[1*], *Hery* Bachrizal Tanjung[1], *Azrifirwan*[1], and *Sherly* Novitasari[1]

[1]Study Program of Extension and Development Communication, Graduate School, Universitas Andalas, Padang, Indonesia

Abstract. The existence of information and communication technology (ICT) has great potential in improving the performance of agricultural extension workers as facilitators, communicators, and innovators of agricultural development. This study aims to describe the level of ICT utilization by agricultural extension workers and analyze the internal and external factors that influence it in improving the performance of extension workers. The research approach used is quantitative with a survey method of 84 agricultural extension workers using a total sampling technique. Data were analyzed using a structural equation model (SEM-PLS) to test the relationship between variables. The results of the study indicate that the level of ICT utilization and the performance of agricultural extension workers are in the good category. Internal factors (age, education, work experience, equipment ownership) and external factors (institutional support, policies, infrastructure) have a significant influence on ICT utilization, while ICT utilization is proven to play a significant mediating variable in improving the performance of extension workers. Optimal utilization of ICT has been proven to play an important role in strengthening the effectiveness of agricultural extension workers, especially in improving the ability of extension workers to carry out their communicative and educational functions in the field.

1 Introduction

The development of modern technology has brought about significant changes in human life. These changes are not only visible in the aspects of communication and information but also extend to almost all sectors, including agriculture. The advancement of information and communication technology (ICT) has become one of the main pillars of the Industrial Revolution 4.0, which requires every sector to transform and adapt to digital-based systems. To encourage the utilization of ICT in agricultural extension, infrastructure, internet penetration, individual capacity, and motivation are essential [1]. In the agricultural sector, this development brings both great opportunities and challenges, particularly in terms of how digital technology can be integrated into the agricultural extension system as a bridge between innovation and farmers.

Sustainable agricultural development today is not only oriented toward production results but also focuses on improving the quality of human resources in agriculture. This approach integrates economic, social, and environmental dimensions, aiming to preserve nature, provide economic benefits, and enhance farmers' welfare [2, 3] also emphasized that sustainable agriculture can only be achieved if the farming community actively participates in all stages of development, from planning and implementation to the utilization of outcomes.

They are expected not only to master knowledge and technology but also to assist farmers in adopting innovations sustainably. According to Ahuja [4], the availability of information through the internet has been proven to accelerate and improve the effectiveness of agricultural extension. Without the utilization of technology, the role of extension workers risks being hampered by limitations in distance, time, and access to information. Therefore, the ability of extension workers to master ICT becomes one of the crucial factors determining the success of agricultural extension in the digital era.

However, in recent years, agricultural development has faced stagnation in agricultural information and innovation, which has ultimately affected the optimization of extension systems amidst the rapid expansion of agricultural products in the globalization era [5]. This condition indicates a gap between the results of agricultural innovation research and its implementation at the farmer level. Extension services, which should serve as the medium for disseminating innovations, are often hindered by the limited access of extension workers to up-to-date information. This has implications for the suboptimal performance of extension activities in supporting agricultural development.

* Corresponding author: bbbasrilbasyar4@gmail.com

This stagnation in agricultural development indicates that Indonesia's agricultural extension system has not been functioning optimally. This is inseparable from the performance of agricultural extension workers as the main actors in the process of disseminating information and innovation. The performance of extension workers essentially reflects how well they can plan, implement, evaluate, and report extension activities [3].

Several previous studies have shown that the use of ICT has made a real contribution to improving the performance of extension workers. Mubarokah et al. [6] found that the use of the internet can enhance the ability of extension workers in preparing reports, materials, and extension programs. Furthermore, they reported a positive and significant relationship between ICT utilization and the work effectiveness of field agricultural extension workers. These findings illustrate that the improvement of extension worker performance is greatly influenced by the extent to which they are able to utilize information and communication technology in their duties.

Reflecting on Japan, one of the most earthquake-prone countries, the use of information technology there has apparently reached the point of providing very early warnings of potential earthquakes in specific locations.

This has a significant impact on Japanese society. With early warnings, people can mentally prepare themselves and secure everything they need, including important documents, financial resources, and valuables. They can even evacuate early before an earthquake strikes, which would make it difficult for them to migrate elsewhere. Early warning can reduce or minimize losses from natural disasters. This is something that Indonesia should also develop, given our archipelagic nature, where earthquakes, tsunamis, and potential volcanic eruptions pose a significant threat. This includes enhancing the role of information technology in providing early information about potential natural disasters in specific areas.

Haswar [5] found that although extension workers have begun to use WhatsApp, Facebook, and YouTube for communication purposes, limitations in computer facilities, internet networks, and smartphone ownership among farmers remain significant obstacles. This shortage of extension workers increases their workload, making ICT utilization crucial for expanding the reach of extension services. Nevertheless, ICT utilization in Agam remains suboptimal.

Communication infrastructure limitations are also a problem in Agam Regency. Antara Sumbar (2017) reported that around 39 out of 82 *nagari* (45 percent) and 63 out of 467 *jorong* are still classified as internet blank spots. This condition makes it difficult for many rural areas to access digital information. However, equal internet access remains a challenge. As a result, extension workers in blank-spot areas cannot fully utilize ICT to support extension activities.

Thus, although ICT utilization offers great potential in supporting agricultural extension activities, the data above show that there is still a gap between potential and actual utilization. This theory synthesizes eight models of technology acceptance, including the Technology Acceptance Model (TAM) and the Diffusion of Innovations (DoI), making it more comprehensive in explaining factors that influence technology adoption and use.

UTAUT explains that individuals' intentions and behaviors in using technology are influenced by four main constructs: performance expectancy, effort expectancy, social influence, and facilitating conditions. Internal factors such as age, education, work experience, ICT equipment ownership, and information needs can be mapped into performance expectancy and effort expectancy constructs. Extension workers with higher levels of education and experience, as well as greater information needs, are more likely to believe that ICT is beneficial in improving their performance while also finding it easier to use.

Meanwhile, external factors such as infrastructure availability, government policies, internet access, and institutional support are closely related to the constructs of social influence and facilitating conditions in UTAUT. Institutional and policy support encourages extension workers to be more open to utilizing ICT, while adequate infrastructure and internet access strengthen facilitating conditions, enabling optimal technology use. Thus, the utilization of ICT by agricultural extension workers is determined not only by individual motivation and ability but also by the external support they receive. Based on this framework, this study focuses on analyzing the factors influencing ICT utilization among agricultural extension workers in Agam Regency and examining the extent to which such utilization contributes to improving their performance.

2 Research method

This study employs a quantitative approach. The type of research used in this study is explanatory research. The population in this study consists of all agricultural extension workers serving in Agam Regency, totaling 84 individuals. The study uses a total sampling technique, meaning that the entire population of 84 agricultural extension workers was used as the research sample, distributed across all sub-districts in Agam Regency according to their respective work areas.

The data collection method used in this research is the survey method, which involves collecting primary data through the distribution of questionnaires to respondents. In total, 83 questionnaires were deemed complete and eligible for analysis.

An ordinal scale was employed to provide informative measurement. The data categorization was based on specific characteristics, using a scale ranging from positive to negative gradations. Each indicator was measured by assigning scores on a 1–5 scale.

Data were analyzed using the Structural Equation Model (SEM) with the Partial Least Squares (PLS) method, employing the SmartPLS 4.0 software. The evaluation of the PLS-SEM model, according to Ghozali (2021), was conducted by assessing both the outer model and the inner model [7].

2.1 Validity test evaluation outer model (measurement model)

The validity test was conducted using convergent validity (loading factor and Average Variance Extracted/AVE) and discriminant validity (cross-loading), while the reliability test employed composite reliability and Cronbach's alpha.

2.1.1 Convergent Validity

At this stage, the assessment is based on the outer loading indicators and the Average Variance Extracted (AVE). The results of the convergent validity test are presented below.

Data are considered to have convergent validity if the outer loading value is greater than 0.70. Based on the analysis, all indicators show outer loading values above 0.70, indicating that all indicators meet the convergent validity criteria.

In addition, convergent validity can also be evaluated using the AVE value. According to Fornell and Larcker (1981), the AVE value should be greater than 0.50 to fulfill the requirements of convergent validity and reliability. Details of the AVE analysis results are shown in Table 1.

Table 1. Results of AVE test

Variable	*Average Variance Extracted* (AVE)	Conclusion
Internal Factors (X1)	0.709	Valid
External Factors (X2)	0.718	Valid
ICT Utilization Rate (Y1)	0.706	Valid
Extension Worker Performance (Y2)	0.758	Valid

Based on Table 1, all variables have AVE values greater than 0.50, indicating that all variables in this study meet the requirements for convergent validity (See Fig. 1 for the evaluation outer model).

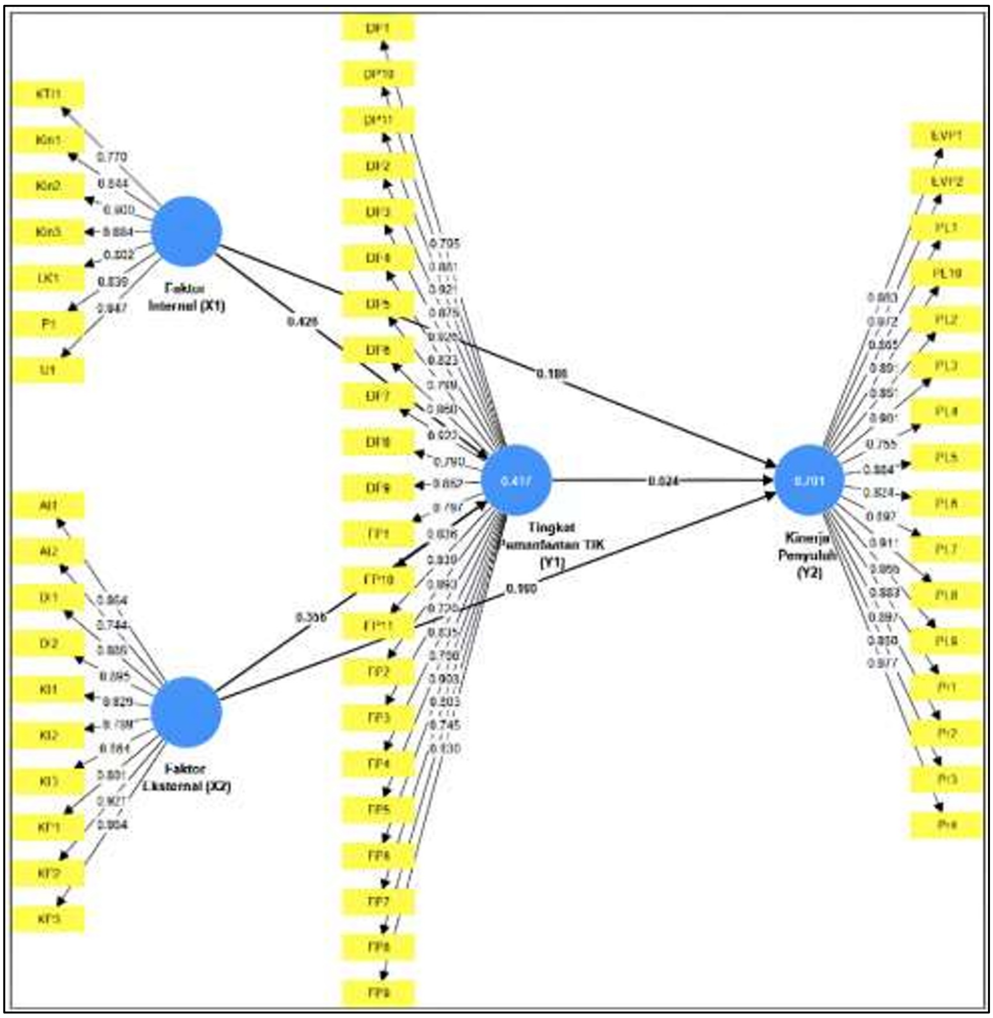

Fig. 1. Evaluation outer model

2.1.2 Discriminant Validity

Discriminant validity is a metric used to assess the extent to which a construct is distinct from other constructs. The underlying principle of discriminant validity is to determine how uniquely an indicator represents its construct versus how much it correlates with other constructs in the model.

In this study, discriminant validity was assessed using the cross-loading method. According to [24], for reflective indicators, the cross-loading value for each variable must exceed 0.70. The results show that all variables have cross-loading values greater than 0.70, indicating that all variables meet the discriminant validity requirement.

2.2 Reliability test evaluation outer model (measurement model)

The most common measure of reliability is internal consistency. To test internal consistency, the researcher used indicators such as Cronbach's Alpha and Composite Reliability (ρc).

In this reliability test, data are considered reliable if the Cronbach's Alpha value is greater than 0.70 and the Composite Reliability (ρc) value is greater than 0.70.

Based on Table 2 below, all variables have Cronbach's Alpha and Composite Reliability (ρc) values above 0.70, which means that all variable constructs are considered reliable.

Table 2. Results of reliability test

Variable	Cronbach's Alpha	Composite Reliability	Conclusion
Internal Factors (X1)	0.931	0.944	Reliable
External Factors (X2)	0.956	0.962	Reliable
ICT Utilization Rate (Y1)	0.980	0.981	Reliable
Extension Worker Performance (Y2)	0.979	0.980	Reliable

3 Results and discussion

3.1 Characteristics of agricultural extension workers

3.1.1 Characteristics based on age classification

The following is a table of respondent characteristics by age:

Table 3. Classification of respondents by age

No	Age	Total	Percentage
1	<30 years	15	18.07%
2	30-39 years	8	9.64%
3	40-50 years	37	44.58%
4	>50 years	23	27.71%
	Total	**83**	**100%**

Based on Table 3, most agricultural extension workers fall within the age range of 40–50 years, totaling 37 individuals (44.58%) of all respondents. Respondents aged over 50 years number 23 people (27.71%), while those under 30 years account for 15 people (18.07%). The 30–39year age group is the smallest, comprising 8 people (9.64%). These findings indicate that the majority of agricultural extension workers in the study area are in their mid-productive to pre-retirement age group.

3.1.2 Characteristics based on education level

Table 4 shows that the majority of agricultural extension workers have an undergraduate degree (Bachelor's/S1), totaling 48 people (57.83%). Furthermore, 23 people (27.71%) hold a Diploma, and 10 people (12.05%) have completed senior high school/vocational school (SMA/SMK). Meanwhile, only 2 respondents (2.41%) possess a Master's degree (S2), and none hold a Doctoral degree (S3).

Table 4. Classification of respondents by education level

No	Last completed education	Total	Percentage
1	SMA/SMK	10	12.05%
2	Diploma	23	27.71%
3	Bachelor's (S1)	48	57.83%
4	Master's (S2)	2	2.41%
5	Doctoral (S3)	0	0.00%
	Total	**83**	**100%**

3.1.3 Characteristics based on years of service

Table 5 show classification of respondents by years of service

Table 5. Classification of respondents by years of service

No	Years of service	Total	Percentage
1	<5 years	21	25.30%
2	5-10 years	14	16.87%
3	11-15 years	7	8.43%
4	16-20 years	31	37.35%
5	>20 years	10	12.05%
	Total	**83**	**100%**

Table 5 indicates that the length of service among agricultural extension workers varies considerably. Most respondents have 16–20 years of work experience, totaling 31 people (37.35%). Those with less than 5 years of experience amount to 21 people (25.30%), followed by 14 respondents (16.87%) with 5–10 years of experience. Meanwhile, 10 people (12.05%) have more than 20 years of service, and 7 people (8.43%) fall into the 11–15 years category.

3.1.4 Characteristics based on employment status

Table 6. Classification of respondents by employment status

No	Position Status	Total	Percentage
1	PNS	54	65.06%
2	PPPK	17	20.48%
3	THL KAB	10	12.05%
4	THL TB PP	2	2.41%
	Total	**83**	**100%**

According to Table 6, most respondents are civil servants (PNS), totaling 54 people (65.06%). Additionally, 17 respondents (20.48%) are Government

Employees under Work Agreements (PPPK), while 10 respondents (12.05%) serve as District Contract Extension Workers (THL KAB). Only 2 respondents (2.41%) are categorized as Contract Extension Assistants (THL TB PP).

3.2 Utilization of information and communication technology (ICT)

Information and Communication Technology (ICT) in the agricultural sector has become an essential strategy to support agricultural development in the digital era. Agricultural extension workers, as the spearhead of agricultural development, not only act as information disseminators but also as communicators, facilitators, innovators, and consultants for farmers. This role requires extension workers to remain open to technological advancements to perform their duties more effectively and efficiently.

The use of ICT helps protect communities from disasters. Agam Regency is a disaster-prone area, particularly around Mount Marapi. Eruptions from this volcano have claimed many lives, both human and livestock. Through ICT, the performance of extension workers in providing information to livestock farmers on how to save themselves and their livestock will improve, as discussed in the ICT utilization discussion above.

Through ICT, extension workers can establish farming networks, access up-to-date agricultural information, and assist farmers in improving farming efficiency and productivity. Therefore, their ability to adapt from conventional to digital approaches represents a strategic step in advancing toward Agriculture 4.0.

In this study, ICT utilization by agricultural extension workers in Agam Regency was analyzed using two indicators — frequency and duration of use — to describe the extent of ICT adoption in extension activities.

3.3 Ownership of ICT devices for internet access

Based on Table 7, the findings reveal that nearly all respondents own more than one ICT device. 62 respondents (74.70%) own both a smartphone and a laptop, while 14 respondents (16.87%) possess a combination of smartphone, laptop, and desktop computer. Only 7 respondents (8.43%) own a smartphone only, and none own an additional tablet device. These results indicate that ICT device ownership among agricultural extension workers is relatively complete, with smartphones and laptops being the dominant tools.

Table 7. Ownership of ICT devices (units)

No	Ownership of ICT (unit)	Total	Percentage
1	Smartphone	7	8.43%
2	Smartphone and Laptop	62	74.70%
3	Smartphone, Laptop, and Computer	13	15.66%
4	Smartphone, Laptop, Computer, and Tablet	1	1.20%
	Total	**83**	**100%**

3.4 Use of media based on ICT type

From Table 8, it can be seen that the most frequently used ICT device is the smartphone, owned by 78 respondents (93.98%). The WhatsApp application also plays a significant role, used by 77 respondents (92.77%), followed by laptops (77.11%), computers (62.65%), and social media platforms such as Facebook (68.67%) and YouTube (61.45%). Additionally, several respondents utilize agriculture-based applications such as Simluhtan (51.81%), e-RDKK (54.22%), and Si Katam (24.10%).

Table 8. Frequently used ICT types

No	Types of ICT	Total	Percentage
1	Smartphone	78	93,98%
2	Laptop	64	77,11%
3	Computer	52	62,65%
4	WhatsApp	77	92,77%
5	YouTube	51	61,45%
6	Facebook	57	68,67%
7	Instagram	42	50,60%
8	Simluhtan	43	51,81%
9	Si Katam	20	24,10%
10	e-RDKK	45	54,22%
11	Website Cyber Extension	29	34,94%

3.5 Usage based on frequency and duration

Table 9. Frequency, duration, and internet network quality

No	Frequency and Duration	Total	Percentage
1	**Frequency**		
	High > 6 Times/Week	34	40,96%
	Medium 3-6 times/week	42	50,60%
	Low <3 times/week	7	8,43%
2	**Duration**		
	High > 6 Hours/Day	39	46,99%
	Medium 3-6 hours/day	33	39,76%
	Low >3 hours/day	11	13,25%
3	**Network Quality**		
	Good	17	20,48%
	Pretty Good	51	61,45%
	Bad	15	18,07%

Based on Table 9, most extension workers use ICT with moderate frequency (3–6 times per week), totaling 42 people (50.60%). Meanwhile, 34 respondents (40.96%) use ICT frequently (>6 times per week), and only 7 respondents (8.43%) use it infrequently (<3 times per week).

In terms of duration, most extension workers use ICT for more than 6 hours per day, totaling 39 respondents (46.99%), while 33 respondents (39.76%) fall in the moderate category (3–6 hours/day), and 11 respondents (13.25%) use it for less than 3 hours/day. These findings indicate that ICT utilization intensity among agricultural extension workers is relatively high in both frequency and duration.

Regarding internet network quality, most respondents (51 people or 61.45%) rated it as “fair,” while 17 respondents (20.48%) rated it “good,” and 15 respondents (18.07%) considered it “poor.” This suggests that although internet access is available, network quality remains uneven, which may affect the smooth implementation of ICT-based extension activities.

3.6 Performance of Agricultural Extension Workers

The performance of agricultural extension workers in Agam Regency is also discussed in the Regulation of the Minister of Agriculture of the Republic of Indonesia No. 91 of 2013, which consists of three main indicators:

1. Preparation for agricultural extension,
2. Implementation of agricultural extension, and
3. Evaluation and reporting of agricultural extension.

To assess the Extension Workers' Performance variable, data were collected through 16 questionnaire items. The analysis was based on the total score obtained for each variable, calculated by summing all responses and converting them into percentage scores using the following scale:

1. 0–20% - Very Poor
2. 21–40% Poor
3. 41–60% Fair
4. 61–80% Good
5. 81–100% Very Good

Table 10 below presents the categories of agricultural extension workers' performance as perceived by the respondents.

Table 10. Categories of agricultural extension workers' performance

Category	Total	Percentage
Very Less	0	0,00%
Less	0	0,00%
Pretty Good	16	19,28%
Good	39	46,99%
Excellent	28	33,73%
TOTAL	**83**	**100,00%**

Based on Table 10, it can be concluded that the overall performance of agricultural extension workers in Agam Regency is categorized as good. Out of 83 respondents, 39 (46.99%) fall into the "good" category, 28 (33.73%) are in the "very good" category, and 16 (19.28%) are in the "fair" category. No respondents were categorized as "poor" or "very poor," each representing 0.00%.

3.7 Evaluation of the inner model (structural model): Hypothesis testing

In this study, hypothesis testing was conducted by processing data using the Bootstrapping function with 5,000 resamples (two-tailed) in SmartPLS 4. The determination of hypothesis testing results was based on the P-values displayed in the Path Coefficients table and by observing the R-Square (R^2) values. The following are the results of the hypothesis testing obtained from the Bootstrapping process in SmartPLS (See Fig. 2 for the inner model).

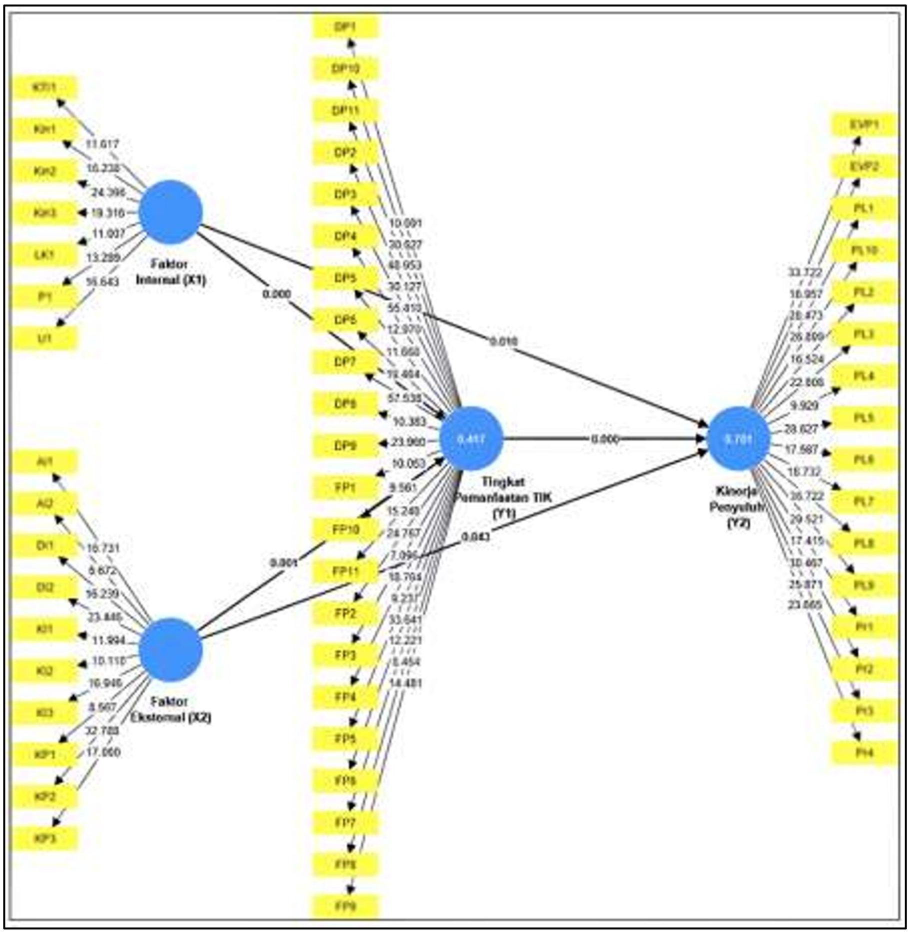

Fig. 2. Inner model

Table 11. Results of direct effect significance test

Path	Path Coefficients	T Statistics (|O/stdev|)	P values	R-square
X1-Y1	0.426	4.496	0.000	0.431
X2-Y1	0.356	3.290	0.001	
X1-Y2	0.186	2.593	0.010	
X2-Y2	0.160	2.029	0.043	
Y1-Y2	0.624	7.823	0.000	0.712

Based on Table 11 above, the R-square value for the variable ICT Utilization (Y1) is 0.431, indicating that 43.1% of the variation in ICT utilization can be explained by internal and external factors, while the remaining 56.9% is influenced by other factors outside the research model. This value falls within the moderate category [8], which means that the model can explain the relationships among variables with a fairly good level of reliability.

Meanwhile, the R-square value for the variable Extension Workers' Performance (Y2) is 0.712, indicating that 71.2% of the variation in the performance of agricultural extension workers can be explained by internal factors, external factors, and ICT utilization, while the remaining 28.8% is influenced by other factors outside the model. According to the guidelines of Hair et al. (2016), this value falls within the strong category, which shows that the model has a high predictive capability toward the performance of agricultural extension workers [8].

Based on the results of the direct effect significance test, the findings are as follows:

3.7.1 Internal factors (X1) - Level of ICT Utilization (Y1)

Internal Factors (X1) Have a Significant Effect on the Level of ICT Utilization (Y1), the t-statistic value of 4.496, path coefficient value of 0.426, and p-value of 0.000 (<0.05) indicate that the hypothesis is accepted.

These results show that the higher the internal factors (X1), the higher the level of ICT utilization (Y1). In addition, the P-value, which is lower than 0.05, indicates that the relationship between X1 and Y1 is statistically significant. This reinforces the finding that internal factors (X1) indeed have a positive and significant influence on the level of ICT utilization (Y1).

Table 12. Results of validity testing for internal factors (X1)

Indicator	Loading Factor	P Value	Average variance extracted (AVE)
Age	0.847	<0.001	0.709
Education Level	0.838	<0.001	
years of service	0.801	<0.001	
Ownership of ICT	0.770	<0.001	
Information Needs	0.876	<0.001	

Based on Table 12 the level of ICT utilization among extension workers is influenced by internal factors such as age, education level, years of service, ICT ownership, and information needs. To see the results of the validity testing of the internal factor variable (X1).

Based on the results of the convergent validity test for the internal factors variable (X1) presented in Table 12, all indicators show loading factor values above 0.70, ranging from 0.770 to 0.876. This indicates that each indicator has a strong correlation with the latent construct it measures [8]. Therefore, all indicators representing internal factors are declared convergently valid, as they meet the minimum threshold of 0.70 as recommended by Ghozali and Hair [7, 8].

Furthermore, the Average Variance Extracted (AVE) value of 0.709 also indicates that more than 70.9% of the variance of the indicators can be explained by the internal factors construct. This value is well above the minimum criterion of 0.50, which means that the construct has good indicator representation ability [8]. Overall, these results confirm that the instrument used to measure internal factors has excellent convergent validity and is reliable for further analysis.

The indicators forming the internal factors variable consist of age, education level, years of service, ICT ownership, and information needs. These five indicators are consistent with the Unified Theory of Acceptance and Use of Technology (UTAUT) explained by Venkatesh et al. (2003) [9], which states that personal and psychological factors influence an individual's intention and behavior toward technology use. In the context of this study, extension workers who are in their productive age, possess higher education levels, have longer work experience, and show higher ownership and need for information tend to be more prepared and capable of utilizing ICT in extension activities.

This finding also reinforces the view of Rogers [10] in the Diffusion of Innovation Theory, which posits that individual characteristics such as education level, experience, and openness to information are important determinants in the technology adoption process. Thus, internal factors are proven to make a significant contribution in shaping extension workers' behavior toward ICT utilization in the field.

This result is consistent with previous studies by Mubarokah and Purwatiningsih which show that the individual characteristics of extension workers, including education and work experience, positively affect the level of technology utilization in extension activities [6, 11]. Therefore, the high validity values of the indicators in the X1 variable show that the instrument successfully captured the internal factor dimensions comprehensively, consistent with the theoretical foundation used in this research.

3.7.2 External factors (X2) - Level of ICT Utilization (Y1)

External Factors Have a Significant Effect on the Level of ICT Utilization, the t-statistic value of 3.290, path coefficient of 0.356, and p-value of 0.001 (<0.05) indicate that the hypothesis is accepted.

External factors (X2) in this study are independent variables that are assumed to have a positive influence on the dependent variable, namely the level of ICT utilization (Y1). The path coefficient value of 0.356 shows that every one-unit increase in the X2 variable results in an increase of approximately 0.356 units in Y1.

The P-value of less than 0.001 indicates a highly significant relationship between X2 and Y1. Based on the $\alpha < 0.05$ criterion, external factors have a positive influence on the level of ICT utilization.

This finding shows that the level of ICT utilization among agricultural extension workers is influenced by external factors, namely availability of ICT infrastructure, government policy, internet access, and institutional support.

Table 13. Results of validity testing for external factors (X2)

Indicator	Loading Factor	P Value	Average variance extracted (AVE)
Availability of Infrastructure	0,828	<0,001	0,718
Government Corruption	0,862	<0,001	
Internet Access	0,804	<0,001	
Agency Support	0,890	<0,001	

Based on the results of the convergent validity test for the external factors variable (X2) shown in Table 13, all indicators have loading factor values above 0.80, ranging from 0.804 to 0.890. These values meet the minimum threshold of 0.70 as suggested by Hair et al., which means that each indicator has a strong correlation with the external factor construct. Therefore, all indicators are declared convergently valid in measuring the external factors variable.

The Average Variance Extracted (AVE) value of 0.718 indicates that 71.8% of the variance of all indicators can be explained by the external factor construct, while the remaining 28.2% is explained by other variables outside the model. This AVE value, which is well above 0.50, shows that the external factors construct has a high level of convergent validity [7, 8].

The indicators forming the external factors variable in this study include the availability of infrastructure, government policy, internet access, and institutional support. These four indicators reflect aspects of the work environment and systemic support that affect the ability of extension workers to utilize ICT. Conceptually, this is consistent with the Unified Theory of Acceptance and Use of Technology (UTAUT), which explains that facilitating conditions are one of the key determinants of technology use behavior [9]. External factors such as organizational support, policy, and infrastructure availability play a role in creating conditions that enable users to utilize technology optimally.

Furthermore, this finding aligns with the studies of Munir (2010) [12], which emphasize that institutional support and local government policy greatly influence the effectiveness of extension workers in accessing and using ICT. Adequate ICT infrastructure and internet access enable extension workers to obtain agricultural information quickly and accurately, while institutional and policy support provide legitimacy and resources for implementing digital-based extension.

Therefore, the results of the convergent validity test on the external factors variable strengthen the argument that the successful utilization of ICT by agricultural extension workers is not solely determined by individual capacity but also heavily depends on structural and institutional support. This shows that external factors play an important role in creating an ecosystem that supports improved extension worker performance in Agam Regency.

3.7.3 Internal factors (X1) - extension worker performance (Y2)

Internal Factors Have a Significant Effect on Extension Worker Performance, the t-statistic value of 2.593, path coefficient of 0.186, and p-value of 0.010 (<0.05) indicate that the hypothesis is accepted.

The path coefficient value of 0.186 shows that the X1 variable (internal factors) has a positive influence on Y2 (extension worker performance). This means that the better the internal factors possessed by the extension worker, the higher their performance tends to be. The T-statistic value of 2.593 and the P-value of 0.010 (<0.05) indicate that this influence is statistically significant.

However, the magnitude of this influence is relatively weak or moderate since the path coefficient is smaller compared to other paths such as Y1 → Y2 (0.624) and X1 → Y1 (0.426). Thus, although internal factors directly affect extension performance, their contribution is not as large as the indirect effect that occurs through the mediating variable Y1 (ICT utilization).

3.7.4 External factors (X2) - extension worker performance (Y2)

External Factors Have a Significant Effect on Extension Worker Performance, the t-statistic value of 2.029, path coefficient of 0.160, and p-value of 0.043 (<0.05) indicate that the hypothesis is accepted.

The path coefficient value of 0.160 also indicates a positive influence between X2 (external factors) and Y2 (extension worker performance). The T-statistic value of 2.029 and the P-value of 0.043 (<0.05) indicate that this effect is statistically significant, although it is at the borderline of significance.

The small coefficient value shows that the direct effect of external factors on extension performance is relatively weak. In other words, improvements in performance are not solely determined by external factors directly but are more strongly influenced by ICT utilization (Y1) as an intermediary variable, which has a much greater impact (Path coefficient Y1 → Y2 = 0.624).

3.7.5 Level of ICT Utilization (Y1) - extension workers performance (Y2)

The Level of ICT Utilization Has a Significant Effect on Extension Worker Performance, the t-statistic value of 7.823, path coefficient of 0.624, and p-value of 0.000 (<0.05) indicate that the hypothesis is accepted.

The level of ICT utilization (Y1) in this study is an independent variable assumed to have a positive influence on the dependent variable, namely the performance of agricultural extension workers (Y2). Based on the path coefficient analysis, a coefficient value of 0.624 indicates that each one-unit increase in ICT utilization results in an increase of 0.624 units in the performance of extension workers.

A P-value of less than 0.001 indicates that the relationship between ICT utilization (Y1) and extension performance (Y2) is statistically highly significant. This means that the level of ICT utilization has a real effect on improving the performance of agricultural extension workers in Agam Regency. Therefore, the hypothesis stating that ICT utilization has a positive and significant effect on extension performance is accepted because the significance value meets the criterion $\alpha < 0.05$ [8].

This result shows that the higher the level of ICT utilization by extension workers (in terms of frequency and duration), the better their performance in carrying out extension duties

Table 14. Validity test results for ICT utilization (Y1)

Indicator	Loading Factor	P Value	Average variance extracted (AVE)
Frequency of Use	0,818	<0,001	0,706
Duration of Use	0,859	<0,001	

Based on the results (Table 14) of the convergent validity test for the variable of ICT utilization (Y1), all indicators used show loading factor values above 0.70 with p-values <0.001. These results indicate that all indicators have significant correlations with their latent construct and have met the criteria of convergent validity recommended by Hair [8]. Therefore, all ICT utilization indicators are declared valid in measuring the intended construct.

In addition, the obtained Average Variance Extracted (AVE) value exceeds the minimum threshold of 0.50, indicating that the ICT utilization construct has good convergent validity. A high AVE value implies that the proportion of variance explained by the indicators is greater than the measurement error variance (Ghozali, 2021) [7]. This means that the indicators used in this study strongly and consistently represent the ICT utilization construct.

Conceptually, the indicators of frequency and duration of use represent the intensity of ICT utilization by agricultural extension workers. The more frequent and longer ICT is used, the higher its utilization in extension activities. This aligns with Munir (2010) [12], who states that ICT utilization can be measured by how frequently and how long the technology is used to support work activities. These two dimensions reflect how well extension workers can integrate ICT into their professional duties, such as obtaining agricultural information, communicating with farmers, disseminating innovations, and conducting online extension reporting.

3.8 Results of the mediation test (indirect effects)

Based on the results of testing ICT Utilization (Y1) as a mediating variable for the effect of internal factors (X1) and external factors (X2) on extension worker performance (Y2), the results are presented in Table 15 below:

Table 15. Results of hypothesis testing (indirect effects)

Path	T statistics (|O/STDEV|)	P values
X1 -> Y1 -> Y2	3.790	0.000
X2 -> Y1 -> Y2	2.948	0.003

Based on Table 15, the following conclusions can be drawn:

3.8.1 Internal factors (X1) -> Level of ICT Utilization (Y1) -> extension worker performance (Y2)

Internal Factors Have a Significant Effect on Extension Worker Performance Through ICT Utilization, the t-statistic value of 3.790 and the p-value of 0.000 (<0.05) indicate that the mediation hypothesis is accepted.

This means that ICT utilization mediates the relationship between internal factors and extension performance. Conceptually, internal factors such as age, education level, work experience, ICT ownership, and information needs determine the ability of extension workers to effectively utilize ICT.

This finding is consistent with Rogers [10] in the Diffusion of Innovation Theory, which states that individual characteristics (internal factors) influence the level of adoption of new technology. Furthermore, the study by Wardani and Anwarudin [13] also found that individual ability and work motivation play important roles in ICT utilization, which ultimately has a positive impact on improving performance.

Therefore, it can be concluded that the stronger the internal factors of extension workers, the higher their ability to utilize ICT, which in turn improves overall performance. ICT utilization acts as a bridge that strengthens the effect of internal factors on extension performance.

3.8.2 External factors (X2) -> Level of ICT Utilization (Y1) -> extension worker performance (Y2)

External Factors Have a Significant Effect on Extension Worker Performance Through ICT Utilization, the t-statistic value of 2.948 and the p-value of 0.003 (<0.05) indicate that the mediation hypothesis is accepted.

This means that ICT utilization serves as an intermediary variable between external factors and extension performance.

In this context, external factors include the availability of ICT infrastructure, government policies, ease of internet access, and institutional support. These factors contribute to creating a conducive working environment that enables extension workers to optimize ICT utilization. For example, the availability of internet networks, digital work tools, and technical training can encourage extension workers to use ICT more actively in extension activities [14].

This finding supports the studies of Anang and Kassem [15], which show that external support, whether in the form of policies or facilities, significantly affects extension performance through improved ICT access and management capability. When external factors function effectively, extension workers have greater opportunities to use ICT as an assistive tool in the extension process, leading to improved performance.

In other words, external factors not only directly influence performance but also indirectly affect it through increased ICT utilization. This underscores that a digitally supportive work environment is a key element in enhancing the effectiveness of agricultural extension in the modern era.

Therefore, it can be concluded that ICT utilization plays a significant mediating role in the relationship between both internal and external factors and extension worker performance. This means that both individual characteristics (internal factors) and work environment support (external factors) will more effectively improve performance when accompanied by strong ICT utilization skills.

Thus, efforts to enhance the performance of agricultural extension workers should not only focus on strengthening individual and institutional capacity but also emphasize digital competency development and the utilization of information technology as essential instruments to support extension activities that are effective, efficient, and adaptive to the changing times.

4 Conclusion

Based on the results of the research entitled "Utilization of Information and Communication Technology (ICT) in Improving the Performance of Agricultural Extension Workers in Agam Regency," the following conclusions can be drawn:

1. The level of ICT utilization among agricultural extension workers in Agam Regency falls under the "good" category. This indicates that most extension workers have used information technology to support extension activities, such as searching for agricultural information, preparing reports, and communicating with farmers through digital media. Nevertheless, a small number of extension workers still utilize ICT at a moderate level, indicating the need for enhanced digital skills so that ICT utilization can be more evenly distributed across all work areas.
2. The performance level of agricultural extension workers in Agam Regency is categorized as good. Most extension workers (46.99%) are in the "good" category and 33.73% fall into the "very good" category, while 19.28% are in the "fair" category. This shows that, in general, the performance of agricultural extension workers is already optimal in carrying out their main tasks and functions as facilitators, communicators, motivators, and innovators in agricultural extension activities.
3. ICT utilization serves as a significant mediating variable in the relationship between internal factors and the performance of agricultural extension workers.
   This means that the ability of extension workers to access and use digital technology acts as an important link between individual potential and work outcomes. Extension workers who are able to integrate ICT into their extension activities tend to have better performance in delivering information, assisting farmers, and accelerating the adoption of agricultural innovations.
4. The use of Information and Communication Technology by extension workers in the Agam area, which is a disaster-prone area, can improve the performance of extension workers, especially in anticipating casualties, both human casualties and livestock belonging to the community in the Mount Marapi area.

5 Recommendations

Based on the research findings, it is recommended that local governments and extension institutions enhance their support for ICT utilization by providing adequate supporting facilities, reliable internet access, and regular training programs for extension workers.

Agricultural extension workers are also encouraged to continuously develop their digital competencies so that ICT utilization is not limited to administrative purposes but can be strategically used to expand information outreach and accelerate the dissemination of innovations to farmers.

Furthermore, extension supervisory institutions need to establish policies that encourage the integration of ICT into the agricultural extension system and also disaster management in this area so that extension activities can be carried out more effectively and efficiently.

For future researchers, it is suggested to explore other variables that may influence ICT utilization and extension performance, or to employ a qualitative approach to gain deeper insights into the experiences of extension workers in applying digital technology in the field.

References

1. N. R. Aida, Challenges and opportunities of the Industrial Revolution 4.0 in agricultural development in Indonesia. Journal of Agricultural Socio-Economics, **13**(2), 112–120 (2019).

https://doi.org/10.1051/e3sconf/202567704002

2. S. Sutawi, Sustainable Agriculture and the Challenges of the Industrial Era 4.0. (UB Press, Malang, 2021)
3. Mardikanto, T. (2009). *Sistem Penyuluhan Pertanian* [Agricultural Extension System]. (LPP UNS and UNS Press, Surakarta, 2009)
4. V. Ahuja, Cyber Extension: A Convergence of ICT (Information and Communication Technology) and Agricultural Development. Global Media Journal. **2**(2), (2011). https://www.researchgate.net/publication/280039298_Cyber_extension_A_convergence_of_ICT_and_agricultural_development
5. H. Haswar, F. Ramadhani, and E. Yulinda, Utilization of social media in agricultural extension activities in Agam Regency. Jurnal AgroHumaniora, 10(1), 33–41 (2022).
6. S. Mubarokah, D. Handayani, and L. Rahmawati, The relationship between ICT utilization and the effectiveness of agricultural extension workers' performance in Banyumas Regency. Jurnal Penyuluhan Pertanian, **13**(2), 99–110 (2018).
7. I. Ghozali, Partial Least Squares: Concepts, Techniques, and Applications Using SmartPLS 4.0 for Empirical Research. (Diponegoro University Press, Semarang, 2021)
8. J. F. Hair, G. T. M. Hult, et al., A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM) (2nd ed.). Thousand Oaks, CA: SAGE Publications, Inc. (2016). (online) https://www.researchgate.net/publication/303522804_A_Primer_on_Partial_Least_Squares_Structural_Equation_Modeling_PLS-SEM_2nd_edition
9. V. Venkatesh, M. G. Morris, G. B. Davis, and F. D. Davis, User acceptance of information technology: Toward a unified view. MIS Quarterly, **27**(3), 425–478 (2003). https://doi.org/10.2307/30036540
10. E. M. Rogers, Diffusion of Innovations (5th ed). (Free Press, New York, 2003).
11. E. Purwatiningsih, S. Anwar, and D. Puspitasari, Utilization of information technology by agricultural extension workers in extension activities in Bogor Regency. Jurnal Penyuluhan, **14**(1), 55–67 (2018).
12. Munir, *Kurikulum Berbasis Teknologi Informasi dan Komunikasi* [Curriculum Based on Information and Communication Technology]. (Alfabeta, Bandung, 2010)
13. Wardani and O. Anwarudin, education role of strengthening of land groups and farmers regeneration in Bogor Regency West Java. J. TABARO. **2**(1), 191-200 (2018). (online) https://scispace.com/pdf/peran-penyuluh-terhadap-penguatan-kelompok-tani-dan-4tkpcj2rng.pdf
14. R. W. Arifin, Utilization of Information Technology in Web-Based Natural Disaster Management in Indonesia. Bina Insani ICT J. **3**(1), 1-6 (2016). http://orcid.org/0000-0001-8980-3800
15. Anang, B. T., Bäckman, S., and A. Rezitis, Determinants of ICT adoption in smallholder agriculture: Evidence from Ghana. Technology in Society. **60**, 101223, (2020).