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# THE FACTORS INFLUENCING TECHNOLOGY ADOPTION PROCESS OF FARMERS IN TERM OF AGRICULTURAL EXTENSION POLICY CASE IN CENTRAL JAVA INDONESIA

**Muhamad Rusliyadi[1*], Yanuar Wahyu Yudistira Ardi[1], and Kodrad Winarno[2]**
[1]Polytechnic of Agricultural Development Yogyakarta – Magelang, Magelang, Central Java, Indonesia
[2]Indonesian Centre for Agricultural Education, Jakarta, Indonesia

*Correspondence Email: m_rusliyadi@yahoo.com

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## ABSTRACT

Agricultural extension activities as a form of educational facilities for the community, especially farmers have an important role in making changes with innovations delivered to farmers and making faster adoption to the field. The adoption problem process of innovation can affect the occurrence of behavior changes that can be observed directly or indirectly and give some different gap adoption to the farmer. The study aims to define the application of binary logistics regression in analyzing the factors which that influence the adoption process of innovative technology in vegetable farmers. The research method was used descriptive analysis and binary logistic regression analysis are utilized to analyze the data used in the assessment's implementation. The results of the research after some analysis of stages such as the formation of the initial model test, simultaneous tests, partial test, and model match test obtained. The results of the factors that affect the adoption process of technology is a factor in the number of livestock and vegetable with a value of 0.006 ($p < 0.05$) was a significance, an intensity factor of extension with the value of 0.039 ($p < 0.05$) was a significance, a factor in the distance of residential of women farmers groups to the source of innovation with value of 0.020 ($p < 0.05$) was a significance, and the distance factor of the residential of farmers to the source of capital with a value of 0.010 ($p < 0.05$) was a significance. The research showed that the probability factor influencing of the process technology adoption base on the distance farmer from the capital and sources innovation, the intensity of extensions and also number of livestock and vegetable.

**Keywords**: *adoption process, agricultural extension binary logistic model, innovation, logistic regression, vegetable farmers*

## BACKGROUND

Agriculture plays a critical and strategic role in national economic growth. This is mostly owing to the fact that the agriculture industry continues to provide jobs and food for the bulk of the population in rural areas (Rusliyadi & Jamil, 2020). The agriculture movement depends on the participation in agricultural extension activities are a form of activity for the community which is a means of education outside of school (non-formal), with the aim of improving community welfare, especially for farmers and their families (Alotaibi et al., 2021). Through agricultural extension

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activities there are various new innovations needed by the community and the stakeholder (Rusliyadi et al., 2019). This innovation must be conveyed to the community, in this case farmers/breeders who do business traditionally, so that they can change their behavior. Where it is expected that all new innovations that are outsourced can be well absorbed through a directed adoption process (Bo Li et al., 2021).

Agricultural extension has a strategic role in development, especially in rural areas. The agricultural sector needs to be effectively developed and provided with necessary support so that extension officers can carry out their work efficiently. Moreover, agricultural development requires proper management of extension services and system or infrastructure. Agricultural extension policy, in the form of advanced technology delivery and provision to farmers, is essential for the progress and success of a country. Agricultural technologies invented by an agency or institution or company require a good delivery system so that the farmers can acquire the latest knowledge and approaches in farming. The problems in agricultural extension services should be addressed by the government so that the policy goals and objectives of agricultural development in Indonesia can be achieved. Extension policy plays a crucial role in poverty reduction, because if it is well-developed, it will reduce the number of people living in abject poverty. In order to achieve this end, it requires the effective implementation of decentralization policy where patterns, forms and sorts of extension services should reach people at the grassroots level (Rusliyadi, 2021).

The process of adopting innovation can be seen from the occurrence of changes in behavior (knowledge, attitudes, and skills) of the target that can be observed directly or indirectly (Rusliyadi & Libin, 2018). The adjustment speed or opportunity for innovation adoption can come from the characteristics of respondents such as age, education, family dependents, experience, land/business control and can come from business accessibility such as the distance of settlements to roads, sources of income, innovation, and capital (Rusli, 2013). So that in implementing the technology adoption process, statistical analysis is needed to support the increasing adoption of innovation, technology, which in this paper aims to determine the implementation of binary logistic regression in analyzing the factors that influence the innovation technology adoption process and to find out the best model of binary logistic regression analysis.

The study aims to define the factors that influence the adoption process of innovative technology in vegetable farmers in terms of Agricultural extension policy by the application of binary logistics regression in analyzing. The application of binary logistics regression in analyzing the factors that influence the adoption process of innovative technology of farmers in term of agriculture extension The results of the research after some analysis of stages such as the formation of the initial model test, simultaneous tests, partial test, and model match test obtained.

## RESEARCH METHODS

### Method of Data Collection

The data used in this study are primarily data resulting from the as a study in the Ngudi Rahayu Farmers Group in Samirono Village Semarang, Central Java Province in 2020. The sample was determined by purposive sampling with a total sample of 60 farmer members. Descriptive analysis and binary logistic regression analysis are utilized to analyze the data used in the assessment's

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implementation. Descriptive analysis is used to determine the stages of adoption and the level of adoption that occurs. The stages of adoption, according to Banerjee et al. (2008) consist of awareness, interest, evaluation, trial, and adoption (Silva et al., 2016). While the adoption rate is divided into three categories: low (0.0 - 33.3%), moderate (33.4-66.7%), and high (66.8 – 100%). The adoption measurement activity refers to Abdullah et al. (2016) 's research which measures adoption time into three times stages, starting from 0-1 weeks, more than 1-3 weeks, and 3-5 weeks.

The statistical analysis approach of logistic regression is used to forecast the relationship between the response variable and the predictor variable. Dependent variable which has two or more categories with one or more explanatory variables (independent variable) on a category or interval scale (Hosmer and Lemeshow, 2000). Ordinary linear regression models utilizing the Ordinary Least Square (OLS) approach cannot answer the description of the relationship between response variables with qualitative or categorical features and explanatory variables with two or more categories (Hendayana, 2012). If the linear regression method is forced to analyze data whose response variables have the characteristics as mentioned above, there will be a violation of the Gauss-Markov assumption (Kutner et al., 2004). Ho Dinh et al. (2021) state that when the response variable (outcome or dependent) is binary or dichotomous, the logistic regression analysis is used to characterize the relationship between the response variable (outcome or dependent) and a collection of predictor variables (explanatory or independent). The response variable is dichotomous qualitative data with a value of 1 (one) to indicate the occurrence of an event and a value of 0 (zero) to indicate the non-occurrence of an event. The general form of the logistic regression equation model is formulated as follows:

$$\pi_{(j)} = P(Y = 1 \mid X) = \frac{e^{\beta_0+\beta_1 X_{j1}+\beta_2 X_{j2}+....+\beta_p X_{jp}}}{1+e^{\beta_0+\beta_1 X_{j1}+\beta_2 X_{j2}+....+\beta_p X_{jp}}}$$

The link function used is logit, with the logit of $\pi$ ie:

$$\text{logit}(\pi) = \log\left(\frac{\pi_j}{1-\pi_j}\right) = \beta_0 + \beta_1 x_{j1} + \beta_2 x_{j2} + ... + \beta_p x_{jp}$$

The logistic regression model is used to determine the probability or the occurrence of a situation. The non-linear regression method of logistic regression is used to explain non-linear relationships between X and Y (Hendayana, 2012). Logistic regression does not require a linear relationship between the independent and dependent variables, unlike Ordinary Least Square (OLS) and linear regression. The data also do not have to be normally distributed (Sekele et al., 2020). Based on the data sources obtained, data on technology adoption, characteristics of women farmers, and regional accessibility are as follows:

1. Technology adoption (Y) is a categorical variable as an adoption variable.
   a. Y = 1 to adopt/accept
   b. Y = 0 for not adopting/not accepting
2. As for the predictor variable (X)
   a. Age (X1) is a continuous variable.
   b. Education (X2) is a categorical variable, with values: 1 = Primary School (SD), 2 = Junior High School (SMP), 3 = Senior High School (SMA), 4 = Bachelor (S1/D4).
   c. A continuous variable (X3) is the number of family dependents.

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d. A continuous variable is farming experience (X4).
e. A continuous variable is the number of cattle/vegetable unit (X5).
f. Extension intensity (X6) is a continuous variable.
g. Courage in taking risks (X7) is a categorical variable, worth: 1 = not daring, 2 = doubtful, 3 = daring.
h. Distance from settlement to road (X8) is a continuous variable.
i. X9 is a continuous variable that measures the distance between a settlement and the source of innovation.
j. X10 is a continuous variable that measures the distance between a community and a source of capital.

**Data Analysis Stages**

The data processing uses IBM SPSS Statistics 22.0 Software with the following stages of analysis:

1. Inputting data on technology adoption, characteristics of women farmers, and regional accessibility of women farming members.
2. Analyzing a binary logistic regression model of technology adoption process data.
3. Use the Likelihood Ratio Test to do a simultaneous test.
4. When performing a partial test, the Wald Test is used.
5. Analyzing with Model Fit Test uses Hosmer and Lemeshow test.

**Logistic Regression Model of Technology Adoption**

$$Ln\frac{Pi}{(1-P)} = \alpha + \beta_1 LnUmur + \beta_2 LnPnd + \beta_3 LnTgKlrg + \beta_4 Pglmn + \beta_5 JlTrnk + \beta_6 ItPyl + \beta_7 Kbrnian + \beta_8 JrkJalanry + \beta_9 Jrksmbinvs + \beta_{10} Jrksmbmodl + e$$

Information:

1. Ln Y : Adoption of farm women, (1=adopted, 0=Not adopted).
2. α : Constant.
3. βi : Regression coefficient ( i= 1,2,3,.....,10).
4. LnUmr : Age (years).
5. LnPnd : Education level.
6. LnTgKlrg : Family dependent.
7. LnPglmn : Farming experience (years).
8. LnJlTrnk : Number of cattle/vegetable (heads/units).
9. LnItPyl : Extension intensity (meetings).
10. LnKbrnian : Courage level (not daring, indecisive, daring).
11. LnJrkJalanry : Distance of settlement to highway (m).
12. LnJrksmbinvs : The distance between a settlement and a source of innovation (m).
13. LnJrksmbmodl : The distance between the settlement and the capital sources (m).
14. e : A phrase or a situation that causes a disturbance (error).

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## RESULT AND DISCUSSION

### Data Description

#### *Characteristics of Women Farmers Group*

Overall, the respondents' age consisted of 85% in productive age (15-60 years) and the remaining 15% in unproductive age, with education level of 56.67% being elementary school graduates, 18.33% high school graduates, 13.33% S1/D4 graduates, and 11.67% the graduated junior high school. The number of dependents in the family is dominated by the number of dependents 1 person by 71.67%, (another 26.67% the number of the dependents of the family is 2-3 people and 1.66% the number of dependents of the family 4. For the experience of raising the respondent, it is 70% respondents have experience in livestock 10 years and the remaining 30% 10 years The number of livestock owned by respondents ranges from 0-4 heads with a percentage of 78.33% and others 5-9 heads by 15%, 10-14 heads by 5%, and 15 tails by 1.67%. Based on the intensity of the extension, only 21.66% of respondents attended extension 2 meetings and the courage to take risks only 6.67% of respondents stated their courage in taking risks which was considered from courage in taking risks, a readiness to take risks, and liking in trying.

#### *Area Accessibility*

Overall, the accessibility of the area in Samirono Village is in good condition. The accessibility of settlements to roads is generally conducive, because geographically, the Samirono Village area is traversed by alternative provincial roads that connect other districts. Respondents' access to sources of innovation is also not too difficult, it's just that the contours of the mountains cause the roads to be taken sometimes are different. As for the distance to the capital is about 2.7 km. It can be said that it is relatively close because of the decent road conditions and light traffic.

### Binary Regression Model for Technology Adoption Process

#### *Early Model*

The estimation of logistic regression parameters used in this initial model is the maximum likelihood method followed by Newton Rapshon iteration. The following is an explanation of the estimated value of the initial model parameters.

**Table 1.** Initial Model Parameters' Estimated Values

| Step 1[a] | B. | S.E. | Wald. | Df. | Sig. | Exp(B). |
|---|---|---|---|---|---|---|
| Age | -0.0370 | 0.0520 | 0.5120 | 1. | 0.4740 | 0.9630 |
| Education | | | 0.7200 | 3. | 0.8690 | |
| Education (1). | 0.6190 | 1.1880 | 0.2710 | 1. | 0.6020 | 1.8570 |
| Education (2). | 0.4420 | 1.2430 | 0.1260 | 1. | 0.7220 | 1.5550 |
| Education (3). | -0.3950 | 1.3150 | 0.0900 | 1. | 0.7640 | 0.673 |
| Sum_dep_family | 0.4760 | 0.4200 | 1.2800 | 1. | 0.2580 | 1.6090 |
| Experience_farm | -0.0010 | 0.0390 | 0.0010 | 1. | 0.9820 | 0.9990 |
| Sum_cattveg | 0.3990 | 0.1460 | 7.4400 | 1. | 0.0060 | 1.4910 |
| Intensity_extens | 2.0440 | 0.9900 | 4.2620 | 1. | 0.0390 | 7.7230 |
| Courage_take_risk | | | 3.5270 | 2. | 0.1710 | |

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| | | | | | | |
|---|---|---|---|---|---|---|
| Courage_take_risk (1) | 10.5980 | 1.1600 | 1.9000 | 1. | 0.1680 | 4.945 |
| Courage_take_risk (2) | -10.7880 | 2.5890 | 0.4770 | 1. | 0.4900 | 0.1670 |
| Distance_street | -0.0120 | 0.0070 | 3.0260 | 1. | 0.0820 | 0.9880 |
| Distance_sources_inovat | 0.0100 | 0.0040 | 5.377 | 1. | 0.0200 | 1.0100 |
| Distance_tocapital | 0.0060 | 0.0020 | 6.7160 | 1. | 0.0100 | 1.0060 |
| Constants | -18.2190 | 6.7550 | 7.2740 | 1. | 0.0070 | 0.0000 |

Source: Processed Primary Data, 2021

Based on the estimated value (B) of each variable in table 1. the initial model can be carried out as follows:

$$\pi(X) = \frac{e^{g(x)}}{1+e^{g(x)}}$$

With the value of g(x) is:

g(x) = − 18.219 − 0.37 age + 0.619 education + 0.442 education (2) − 0.395 education + 0.476 sum_dep_family − 0.01Experince_farm + 0.399 sum_catveg + 2.044_Intensity_ extens + 1.598 courage_take_risk − 1.788598 courage_take_risk − 0.012 distance_street + 0.010 distance_source_inovat + 0.006 distance_tocapital

***Simultaneous Test***

Simultaneous testing uses the probability ratio to determine the model's viability based on parameter estimation findings. The goal of the simultaneous test is to see if the model's predictor variables have a meaningful impact on the entire. Simultaneous testing can be done using the likelihood ratio test and the G test statistic, which is based on a chi square distribution with one degree of freedom (Hosmer and Lemeshow, 2000).

1. Hypothesis
   H0: β1 = β2 = ... =β10 = 0
   H1: at least there is value βj ≠ 0 with j = 1,2,3,....,10
2. Significance level α = 5% = 0,05
3. Test Statistic

**Table 2.** Statistical value of likelihood ratio test

| Step | -2 Log likelihood | Cox & Snell R Square | Negelkerke R Square |
|---|---|---|---|
| 1 | 51.017[a] | 0.382 | 0.519 |

Sources: Primary Data, 2021

Based on a value of -2 log likelihood = 51.017 on the table 2 obtained:

$$G = -2 \ln \left(\frac{likelihood\_tanpa\_variabel\_bebas}{likelihood\_dengan\_variabel\_bebas}\right)$$

$$G = 79.881\text{-}51.017$$

$$G = 29.864$$

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Critical area_Reject H0 if G > $X^2_{(10;0,05)}$

Decision: H0 rejected because G = 29,864 > $X^2_{(10;0,05)}$ = 16.92

Conclusion According to the table can be concluded that at a significance level of 5% the predictor variables contained in the model are: age, education level, number of family dependents, farming experience, number of livestock and vegetable, intensity of extension, courage in taking risks, distance of the settlement to the highway, distance of the settlement to the source of innovation, the distance of settlement of capital has a significant effect simultaneously.

***Partial Test***

Partial test using the Wald test, has the aim of knowing the significance of the parameters on the predictor variables.

1. Hypothesis
   H0 : βj = 0
   H1 : βj ≠ 0 where j = 1,2,3,....,10
2. Significance level
   α = 5% = 0.05
   $Wj = \{\frac{\beta j}{se(\beta j)}\}^2$
3. Critical area
   Reject H0 if Wj > or reject H0 if sig. < α
4. Decision

Based on the Wald value for each variable and its significance in table 3, the results obtained from the Wald test are as follows:

**Table 3.** Decisive result of the Wald test

| Variable | Wald | Df | $X^2_{(10;0,05)}$ | Sig. | Decision |
|---|---|---|---|---|---|
| Age | 0.512 | 1 | 3.84 | 0.474 | H0 accepted |
| Education | 0.720 | 3 | 7.81 | 0.869 | H0 accepted |
| Education (1) | 0.271 | 1 | 3.84 | 0.602 | H0 accepted |
| Education (2) | 0.126 | 1 | 3.84 | 0.722 | H0 accepted |
| Education (3) | 0.090 | 1 | 3.84 | 0.764 | H0 accepted |
| Sum_dep_family | 1.280 | 1 | 3.84 | 0.258 | H0 accepted |
| Experience_farm | 0.001 | 1 | 3.84 | 0.982 | H0 accepted |
| Sum_cattveg | 7.440 | 1 | 3.84 | 0.006 | H0 rejected |
| Intensity_extens | 4.262 | 1 | 3.84 | 0.039 | H0 rejected |
| Courage_take_risk | 3.527 | 2 | 5.99 | 0.171 | H0 accepted |
| Courage_take_risk (1) | 1.900 | 1 | 3.84 | 0.168 | H0 accepted |
| Courage_take_risk (2) | 0.477 | 1 | 3.84 | 0.490 | H0 accepted |
| Distance_street | 3.026 | 1 | 3.84 | 0.082 | H0 accepted |
| Distance_sources_inovat | 5.377 | 1 | 3.84 | 0.020 | H0 rejected |

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| | | | | | |
|---|---|---|---|---|---|
| Distance_tocapital | 6.716 | 1 | 3.84 | 0.010 | H0 rejected |

Source: Primary Data, 2021

Conclusion at a 5% significance level, the variable quantity of livestock and vegetables, intensity of extension, settlement distance from source of innovation, and settlement distance from the capital have a significant effect on the technology adoption process. Meanwhile, age, education level, number of family dependents, experience raising livestock and vegetables, risk-taking courage, and the distance between the settlement and the highway have little bearing on the technology adoption process.

***Model Fit Test***

The Hosmer and Lemeshow test, which assesses the binary logistic regression model's acceptability, was employed to assess the model's suitability.

1. Hypothesis
   H0: suitable model
   H1: the model does not fit
2. Level of significance
   $\alpha = 5\% = 0.05$
3. Test statistics

**Table 4.** Value of Hosmer and Lemeshow Test Statistics

| Step | Chi-square | df | Sig. |
|---|---|---|---|
| 1 | 6.212 | 8 | 0.623 |

Sources: Primary Data, 2021

Based on table 4 obtained the value that:

1. $\hat{C}$ = 6.212
2. Sig. = 0.623
3. Critical area
   Reject H0 if $\hat{C} > X^2_{(10;0,05)}$ =16,92 or sig < α
4. Decision
   $\hat{C}$ = 6,212 < $X^2_{(10;0,05)}$ = 16.92 or sig = 0.623 > α = 0,05, then H0 accepted

Conclusion at the 5% significance level the binary logistic regression model is appropriate. After testing the significance of the model, both simultaneously and partially, the results obtained that the variable number of livestock, intensity of extension, distance of the settlement to the source of innovation, and distance of settlement of capital has a significant effect on the process of adopting the technology.

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***Size Classification Accuracy***

The classification table explains how well the model grouping cases into two groups, both those who accept technology adoption and those who do not accept technology adoption.

**Table 5.** Classification Accuracy

| Observed | | Predicted Adoption Decision | | |
|---|---|---|---|---|
| | | **Not Accepted** | **Accepted** | **Percentage Correct** |
| Step 1 | Not Accepted | 32 | 5 | 86.5 |
| Adoption decision | Accepted | 8 | 15 | 65.2 |
| Overall Percentage | | | | 78.3 |

Sources: Primary Data, 2021

Based on the classification accuracy, it can be seen that the overall prediction accuracy is 78.3%. While the prediction accuracy for those who do not accept technology adoption is 86.5% and the prediction accuracy for those who accept the technology adoption process is 65.2%.

**Factors Affecting of the Respondents Characteristics and Area Accessibility to the Technology Adoption Process**

The factors that affected the findings of the binary logistic regression test are the number of livestock with value of 0.006 ($p<0.05$) was a significance, the intensity of extension factor with value of 0.039 ($p<0.05$) a significance, the distance factor of the female farmers' settlement to the source innovation, value is 0.020 ($p<0.05$) was a significance, and the distance factor of women's farmer settlements to sources of capital value of 0.010 ($p<0.05$) was with a significance. The value of the odds ratio can be used to understand the model in binary logistic regression. The odds ratio's value is used to estimate how much the number of livestock components, the intensity of extension, the distance between settlements and sources of innovation, and the distance between settlements and sources of capital influence the technology adoption process. The interpretation of the value of the logit regression coefficient (B) is carried out in which the antilog is calculated of B or the exponential power of the largest coefficient (exp (β)) (Widarjono, 2010).

## CONCLUSION AND SUGGESTION

The implementation use of binary logistic regression analysis reveals that the number of livestock and vegetable farms has a significant impact on the technological adoption process, with a significance value of 0.006 ($p<0.05$). The extension intensity factor with a value of 0.039 ($p<0.05$) was a significance since the activity is more visible to the farmer. The factor of distance women's farmer settlements to sources of innovation with value of 0.020 ($p<0.05$) was a significance, and the factor of distance of women's settlements from sources of capital with value of 0.010 ($p<0.05$) was a significance this show the distance of farmer settlement was very important in the adoption process. The research showed that the probability factor influencing of technology adoption process base on

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the distance farmer from the capital and source innovation, the intensity of extensions and also number of livestock and vegetable. The adoption process in the research was insightful to the extension activity since several variable has significance impact to the agricultural policy in rural areas. To find out the factors that really influence by the binary logistic regression model, needed further tests by using the stepwise method. The results of the binary logistic regression model's examination of influencing factors can be utilized to determine and assess targets for future extension plan activities.

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