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Modeling Factors Affecting the Length of Early Marriage Using Binary Logistic Regression

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Abstract:

Early marriage refers to a union where one or both partners are below the optimal age, leading to insufficient physical, mental, and material preparedness. This lack of readiness often contributes to emotional and psychological immaturity, increasing the risk of divorce. This research employs a binary logistic regression model to analyze the influencing factors influencing the duration of early marriages, with data sourced from the Supreme Court decision website, focusing on cases in Indramayu Regency. The findings indicate that the number of children, cause of divorce, and age difference significantly influence the likelihood of early marriages lasting more than 5 years, with the number of children being the most influential factor. Conversely, the occupations of both the wife and husband were not statistically significant. Model fit testing yielded a chi-square significance value of 0.569, confirming the model's suitability for explaining the duration of early marriages. Additionally, the model demonstrated a high accuracy rate of 90.1%, highlighting its strong predictive capability. This research offers critical insights into the determinants of early marriage duration and their implications.

Keywords — **Early Marriage, Divorce, Binary Logistic Regression**

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I. INTRODUCTION

Early marriage is defined as a marriage entered into by individuals or both partners with one or both of them having an age below the limit that is considered optimal, which causes physical, mental, and material preparation to reach an adequate level [1]. According to Law No. 16 of 2019 which contains amendments to Law No. 1 of 2974 concerning marriage, that the results of the revision are related to the minimum legal age for marriage in Indonesia, namely a minimum of 19 years for both women and men [2]. However, these ages are classified as adolescents, and adolescents are also classified as a transition period, namely the transition from children to adulthood. Early marriage is currently a concern for all circles in developing countries, Indonesia being one of them [3].

According to 2023 data from the United Nations Children's Fund (UNICEF), Indonesia ranks fourth in early marriage with 25.35 million [4]. This shows that early marriage is a serious issue that needs more attention. This is in line with the fact that the rate of early marriage in Indramayu is high. The Religious Court (PA) recorded that there were 514 applications for marriage dispensation in 2023 [5]. This figure reflects the social and economic conditions that promote early marriage practices, including factors like poverty, limited education, and entrenched cultural norms.

Early marriage also has the potential to lead to divorce. The young age at marriage often makes individuals less emotionally and psychologically mature to deal with household dynamics [6]. In addition, economic pressures, lack of mental readiness, and limited access to supportive resources

can increase the risk of domestic conflict [7]. As a result, marriages that begin at an early age are more prone to instability and dissolution. This is a serious concern as divorce not only affects the couple, but also the children who may be involved, as well as society as a whole [8].

The longevity of early marriage, or the duration between the start of a marriage and its end (through divorce or separation), has attracted attention in recent research. Understanding the factors that influence the longevity of these marriages is critical for policymakers, sociologists and community leaders to address the underlying issue and mitigate its adverse effects [8]. Some of the key factors that influence the length of early marriage, such as education level, socioeconomic status and age at marriage, are strongly associated with the risk of divorce. For example, individuals with low education levels often lack effective communication skills, which can exacerbate household conflicts. Low socio-economic status also adds financial stress, which can accelerate the breakdown of early marriages. In addition, couples who marry too young may lack the emotional maturity necessary to resolve problems, leading to marital instability [7].

Previous research conducted by [9] related to the analysis of factors affecting divorce due to early marriage in 2019 at the Ciamis Religious Court, West Java using a qualitative approac h with interviews. This study found that throughout 2019 divorce in the Ciamis Religious Court, West Java, the most dominant is the economic factor reaching 45,412 which is very influential in the divorce factor in early marriage.Research on the factors that influence divorce in early marriage shows that there are various complex causes. One study by [9] identified two categories of factors causing divorce: internal factors and external factors. Internal factors include household unpreparedness, communication problems, unstable economic conditions, and domestic violence. Meanwhile, external factors include the influence of friendship environment, family interference, and social pressure from the community.

Research on binary logistic regression modeling has been widely conducted and provides valuable insights in binary data analysis. One study by [10] discusses the application of Bayesian methods for parameter estimation in binary logistic regression models, focusing on testing the significance of coefficients and model fit. This study shows that parameter estimation is performed by the maximum likelihood method, which maximizes the likelihood function to obtain the exact coefficients. [11] also conducted binary logistic regression modeling to analyze the factors affecting the Human Development Index (HDI) in Java Island.In this study, the data was divided into training data and test data, and tests were conducted to ensure that there was no multicollinearity between independent variables. The results show a good binary logistic regression model with a classification accuracy of more than 80%.

The uniqueness of this study lies in the application of a binary logistic regression model to analyze the factors that influence the duration of early marriage. Logistic regression was chosen because of its ability to model the relationship between a binary dependent variable (e.g., short or long duration) and various independent variables that are both categorical and continuous [12]. This approach is well suited for this study as it can identify key predictors and measure their relative influence on the outcome [13].

This study aims to analyze the factors that influence the duration of early marriage in Indramayu, including social, economic, and demographic aspects, using binary logistic regression. The variables studied include number of children, reason for divorce, age difference, and occupation of husband and wife. The results are expected to provide insights for policy makers in designing interventions to reduce early marriage and its negative impacts, such as divorce.

II. RESEARCH METHODOLOGY

A. Data Source and Research Variables

This study uses secondary data derived from the website of the Supreme Court Decision of the Republic of Indonesia totaling 382 divorce cases that occurred in early marriage in the Indramayu Regency Religious Court. The variables in this study consist of two types, namely dependent variables and

independent variables. The following is a summary of the research variables in table 1.

TABLE I
EARLY MARRIAGE DIVORCE RESEARCH VARIABLES

Variable	Description	Unit
Y	Length of early marriage age	Nominal
X_1	Number of children	Ratio
X_2	Cause of divorce	Nominal
X_3	Different of age	Ratio
X_4	Wife's job	Nominal
X_5	Husband's job	Nominal

B. Binary Logistic Regression

Binary logistic regression is a statistical method used to examine the relationship between a binary response variable and one or more independent predictor variables. The binary logistic regression response variable consists of two categories, namely success which is denoted by 1 or failure which is denoted by 0 [14]. The dependent variable in binary logistic regression follows a Bernoulli distribution with a probability function as shown in Equation 1 [15].

$$f(y_i) = \pi(x_i)^{y_i}\left(1-\pi(x_i)\right)^{(1-y_i)} \#(1)$$

$\pi(x_i)$ is the probability of the i-th event, and y_i is the i-th random variable consisting of 0 and 1.

In logistic regression, the response variable is written as $y = \pi(x_i) + \varepsilon$, with ε having one of two possible values, namely if $y = 1$ then $\varepsilon = 1 - \pi(x_i)$ with probability $\pi(x_i)$ and if $y = 0$ then $\varepsilon = -\pi(x_i)$ with probability $1 - \pi(x_i)$ [16]. The binary logistic regression probability model can be written as in Equation 2

$$\pi(x) = \frac{\exp\left(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_p x_p\right)}{1 + \exp\left(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_p x_p\right)} = \frac{\exp\left(\beta_0 + \sum_{k=1}^{p}\beta_k x_k\right)}{1 + \exp\left(\beta_0 + \sum_{k=1}^{p}\beta_k x_k\right)} \#(2)$$

If the above equation is written into a logit model, the equation is obtained

$$logit[\pi(x)] = \ln\left(\frac{\pi(x)}{1-\pi(x)}\right) = \beta_0 + \sum_{k=1}^{p}\beta_k x_k \#(3)$$

Value β is the model parameter and $x_k, k = 1,2,\ldots,p$ is the-kth predictor variable [17].

Parameter estimation in binary logistic regression is done using the maximum likelihood estimation (MLE) method. The MLE method produces parameter values by maximizing the likelihood function of the observed data using the log-likelihood function shown in Equation 4 [18].

$$L(\boldsymbol{\beta}) = \sum_{i=1}^{n}[y_i(\boldsymbol{\beta^T x_i}) - \ln(1 + \exp(\boldsymbol{\beta^T x_i}))] \#(4)$$

To obtain the estimated value of $\boldsymbol{\beta}$, Equation 4 is derived from $\boldsymbol{\beta}$ and the result of the derivative is equated to zero, so Equation 5 is obtained [19].

$$\frac{\partial L(\boldsymbol{\beta})}{\partial \boldsymbol{\beta}} = X^T\left(\boldsymbol{y} - \boldsymbol{\pi}(\boldsymbol{x})\right) = 0 \#(5)$$

Based on Equation , the first derivative of the function $L(\boldsymbol{\beta})$ is a non-linear equation, so the exact solution to obtain the estimator $\boldsymbol{\beta}$ cannot be obtained analytically. An alternative method to obtain the $\boldsymbol{\beta}$ estimator is the Newton-Raphson iterative method [19].

$$\hat{\beta}^{t+1} = \hat{\beta}^t - \left(H\left(\widehat{\boldsymbol{\beta}}^{\boldsymbol{t}}\right)\right)^{-1}\boldsymbol{g}\left(\widehat{\boldsymbol{\beta}}^{\boldsymbol{t}}\right) \#(6)$$

$t = 1,2,\ldots$ until it converges

$\boldsymbol{g}\left(\widehat{\boldsymbol{\beta}}^{\boldsymbol{t}}\right) = \frac{\partial L(\boldsymbol{\beta})}{\partial \boldsymbol{\beta}}$ is the derived vector of the first derivative of the log-likelihood function according to equation 5. $H\left(\widehat{\boldsymbol{\beta}}^{\boldsymbol{t}}\right)$ is the Hessian matrix which is the matrix of the second derivative of the$L(\boldsymbol{\beta})$ function with $H\left(\widehat{\boldsymbol{\beta}}^{\boldsymbol{t}}\right) = -X^T VX$.

C. Binary Logistic Regression Model Fit Test

According to [12], said that the model fit test is a test conducted to determine whether there is a difference between predictions and observations (model fit or not).

Hypothesis:

H_0: The model fits (There is no difference between predictions and observations)

H_1: The model does not fit (There is a difference between predictions and observations)

Test Statistic:

$$\hat{C} = \sum_{k=1}^{g}\frac{(o_k - n'_k\bar{\pi}_k)^2}{(n'_k\bar{\pi}_k)(1-\bar{\pi}_k)} \#(7)$$

At significance level $\propto$, H_0 is rejected if$\hat{C} > \chi^2_{(\alpha,g-2)}$ or $p - value < \propto$

D. Parameter Significance Test of Binary Logistic Regression

Parameter significance test is conducted on all parameter coefficients of independent variables on the response variable. This test is conducted simultaneously and partially [20].

The simultaneous test was conducted to test the effect of the β coefficient as a whole in the model, with the following hypothesis:

$H0 : \beta 1 = \beta 2 = \cdots = \beta j = 0$

$H1 : minimal\ terdapat\ satu\ \beta j \neq 0$ with $j = 1,2, \ldots k$

The simultaneous test statistic used for the model is :

$$G^2 = -2 \ln \left[\frac{L(\hat{\omega})}{L(\hat{\Omega})} \right] \#(8)$$

Simultaneous testing using the G-test with the formula in equation 8 follows the Chi-Square distribution χ^2 with degrees of freedom k, where H_0 will be rejected if the value $G > \chi^2_{k;\alpha}$ or $p - value < \alpha$, which means that the independent variables simultaneously have a significant effect on the response variable.

Partial testing is performed to analyze the individual effects of each independent variable parameter by comparing their standard errors. The hypothesis for the partial test is as follows:

$$H_0 : \beta_j = 0$$
$$H_1 : \beta_j \neq 0 , j = 1,2, \ldots , k$$

The partial test statistic used is

$$W = \left[\frac{\widehat{\beta_j}}{SE\widehat{\beta_j}} \right]^2$$

where $\widehat{\beta_j}$ is the estimator of β_j and $SE\widehat{\beta_j}$ is the standard error, W is the Wald test following a Normal distribution. H_0 is rejected if $|W| > Z_{(1:\propto)/2}$, or $p - value < \alpha$, thus implying that the independent variable has an effect on the response variable.

III. RESULTS AND DISCUSSION

A. Characteristics of Research Variables

Descriptive statistics are used to describe the data characteristics of factors that are thought to affect the length of marriage. The following Table 2 presents descriptive statistics for variables characterized by a continuous scale including

TABLE II
DESCRIPTIVE STATISTICS FOR CONTINUOUS SCALE VARIABLES

Variable	Mean	Std. Dev	Min	Max
X_1	1.5340	0,94335	0	5
X_3	5.4738	3.77283	0	27

Average number of children X_1 is 1,5340, ith a standard deviation of 0,94335. This shows that the couples in the data tend to have an average of 1 to 2 children, with a relatively small spread in the number of children. The minimum value of the number of children is 0, indicating that there are childless couples, while the maximum value is 5, meaning that the couple with the highest number of children in the data has five children.

Meanwhile, the average age difference between couples $X_3$is 5,4738 years, with a standard deviation of 3,77283. This shows that on average couples have an age difference of about 5 years, but the variation is quite large compared to the number of children. The minimum value for age difference is 0, meaning there are couples with no age difference, while the maximum value is 27 years, indicating a significant age difference for some couples.

Overall, the data shows that the number of children of couples is relatively homogeneous, while the age difference between couples shows greater variation.

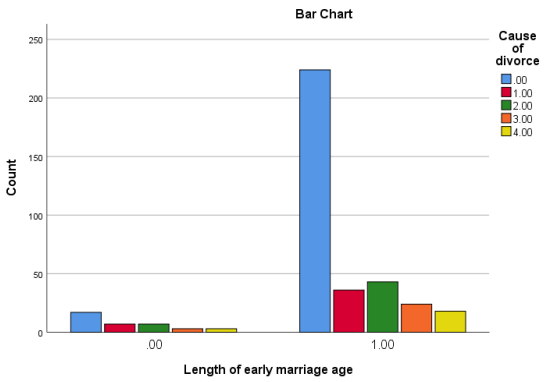

Fig. 1 Bar chart between length of early marriage and causes of divorce

The bar chart shows that couples with an early marriage duration of ≤5 years (category 0) divorced mostly due to economic problems, while other reasons such as family harmony, irresponsibility, infidelity and domestic violence have a smaller frequency. In contrast, for marriage duration >5 years (category 1), the causes of divorce are more

diverse, with family harmony and irresponsibility being the main factors, while economic problems have relatively decreased. This suggests that the main challenge of divorce changes from economic factors in shorter marriages to relationship dynamics in longer marriages.

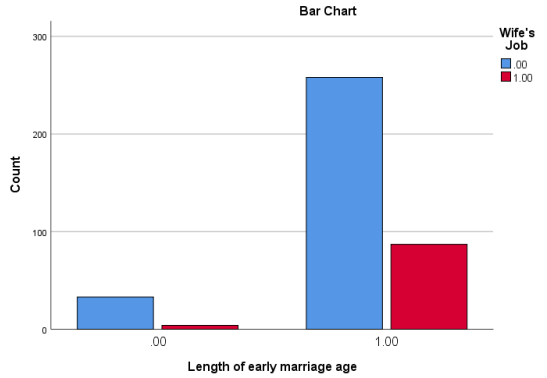

Fig. 2 Bar chart between length of early marriage and wife's job

The graph shows the relationship between length of early marriage age and wife's employment status. In the group of marriages with a duration of more than 5 years (code 1), the majority of wives are not working (code 0), with more than 300 people. Meanwhile, the number of working wives in this group is smaller, about half of the number of non-working wives. In the group of marriages with a duration of less than or equal to 5 years (code 0), there are also more wives who do not work than those who work, but the difference is not as large as in the group of marriages with a duration of more than 5 years. This indicates that in the context of this data, non-working wives are more common in both categories of length of initial marriage, especially in marriages with a duration of more than 5 years.

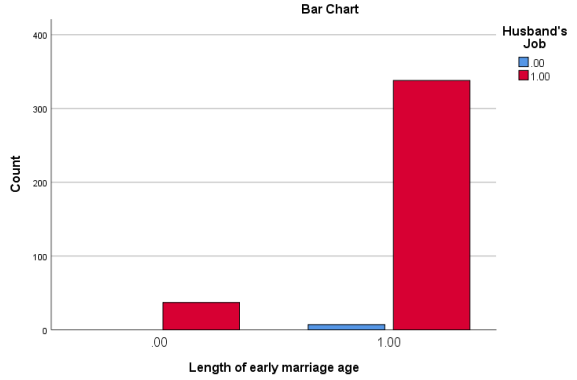

Fig. 3 Bar chart between length of early marriage and husband's job

The graph shows the relationship between length of early marriage age and husband's employment status. In the group of marriages with a duration of more than 5 years (code 1), a large majority of husbands were employed (code 1), with a total of almost 400 people. In contrast, there were very few husbands who did not work (code 0) in this group. For the group of marriages with a duration of less than or equal to 5 years (code 0), there are fewer husbands overall, but the proportion of husbands who are working remains much larger than those who are not working. This suggests that in the context of this data, the majority of husbands are working, regardless of the length of the initial marriage, especially in marriages with a duration of more than 5 years.

B. Simultaneous Test of Binary Logistic Regression

The simultaneous parameter test is carried out to determine whether the predictor variables simultaneously affect the response variable. simultaneously on the response variable. Based on the simultaneous test results using the Likelihood Ratio test value as follows

TABLE IIII
OMNIBUS TEST OF MODEL COEFFICIENT RESULTS

Chi-square	df	Sig.
51,457	5	0,000

Table 3 shows that the significance value of the G-test is 0.000. This indicates that the significance value is smaller than 0.05 which results in the rejection of H_0. The rejection of H_0 means that there is at least one independent variable that has a significant influence on the length of early marriage.

C. Partial Test of Binary Logistic Regression

Partial testing is carried out to see the effect of each independent variable on the length of early marriage age. Testing is done through the Wald test with the results listed in table 4 below

TABLE IIIV
PARTIAL TEST RESULTS USING THE WALD TEST

Variable	B	S.E.	Wald	Sig.	Exp(B)
X_1	1.432	0,276	29.907	**0.000**	4.189
X_2	-0.326	0,146	4.980	**0.026**	0.722

X_3	0.154	0,066	5.453	**0.020**	1.167
X_4	0.961	0,582	2.728	0.099	2.613
X_5	-17.317	14417.684	0.000	0.999	0.000
Constant	17.322	14417.684	0.000	0.999	33326745.91

Based on the results of partial testing of the logistic regression model contained in Table 4 with a significance level of 5%, it shows that there are 3 factors that significantly affect the length of marriage age, including the variable number of children (x_1) with a statistical test value W of 29.907, reason for divorce (x_2) with a value W of 4.980, age difference (x_3) with a value W of 5.453,. From these values it is known that $|W|$ is greater than the value of $Z_{\frac{1;\alpha}{2}}$ with α = 5%. In this case, it is also found that the p-value of each $x1$, $x2$, $x3$ variable is 0.00 which is less than the value of α = 0.05. Because $|W| > Z_{\frac{1;\alpha}{2}}$, or $p - value < \alpha$ it can be concluded that rejecting H_0. This means that the number of children, reasons for divorce and relative age difference partially affect the length of early marriage. So the binary logistic regression model can be expressed as

$$\pi(x) = \frac{\exp(g(x))}{1 + \exp(g(x))}$$

with the logit function

$$g(x) = 1.432x_1 - 0.326x_2 + 0.154x_3$$

D. Model Fit Testing

The next step is model fit using the Hosmer and Lemeshow Goodness of Fit Test (GOF), with the results listed in Table 5

TABLE V
HOSMER AND LAMESHOW GOF TEST RESULTS

Chi-square	df	Sig.
6.699	8	0,569

From table 5, it can be seen that the chi-square significance value is 0.569 so that the decision to accept H_0 is taken, which means that the model is suitable or there is no significant difference between the observations and the model predictions. So it can be concluded that the predicted binary logistic regression model is suitable and can be used to explain the length of early marriage age in Indramayu Regency. The results of this model suitability test are reinforced by the results of the overall percentage model which shows a value of 90.1%, which means that the accuracy of the model in predicting the length of marriage age is 90.1%.

E. Interpretation of Odds Ratio

Based on Table 4, the interpretation of the odds ratio of each variable is as follows: the number of children (x_1) has the greatest influence with an odds ratio of 4.189, which means that each additional child increases the chance of early marriage duration of more than 5 years by 4.189 times, assuming other variables are constant. The cause of divorce (x_2) has a negative effect, with an odds ratio of 0.722, indicating that each increase in the cause of divorce factor reduces the odds of early marriage duration of more than 5 years by 27.8%. Meanwhile, the age difference (x_3) has a odds ratio of 1.167, meaning that each additional year of age difference increases the odds by 1.167 times. Wife's occupation (x_4) has an odds ratio of 2.613, indicating an increase in odds if the wife is employed, but this variable is not statistically significant (p-value = 0.099). Husband's occupation (x_5) has an odds ratio close to zero, but is not statistically significant (p-value = 0.999), so its effect is not reliable.

IV. CONCLUSIONS

Binary logistic regression results show that the number of children (x_1), cause of divorce (x_2), and age difference (x_3) significantly affect the odds of early marriage duration of more than 5 years, with the number of children having the largest effect. The variables of wife and husband's occupation were not statistically significant. Model fit testing showed a chi-square significance value of 0.569, so the model is declared fit and can be used to explain the length of early marriage in Indramayu Regency. The model accuracy rate reached 90.1%, indicating excellent predictive ability.

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