Research Paper

Analysis of the Relationship Between Library Services and Education Factors on the Community Literacy Development Index Using Path Analysis

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Abstract

The application of Path Analysis for causal modelling is widely used in various fields of study, one of which is education. Path Analysis is applied to test the relationship model between variables: CLDI (Community Literacy Development Index) (Y_0), library service equity (X_1), library collection adequacy (X_2), library staff adequacy ratio (X_3), community visit rate per day (X_4), and education completion rate (X_5). In addition, the adequacy of the library collection (X_2), the level of community visits (X_4), and the level of education completion (X_5) significantly affect the CLDI (Y_0). The combination of library and education service variables explained 70.19 per cent of the variation in CLDI. This study concludes the importance of synergy between libraries and education in improving community literacy and recommends strengthening literacy programmes based on library services and quality education.

1. INTRODUCTION

Literacy is the main foundation in developing quality human resources. Literacy skills not only include the ability to read and write, but also involve the ability to think critically, understand information, and adapt to technological and social developments [1]. The Community Literacy Development Index is one of the important indicators in measuring the extent to which a community is able to access, understand, and utilize information for individual and collective progress. Library services play a strategic role as a center for information and knowledge. Libraries provide access to various resources that support literacy development, such as book collections, journals, and digital facilities [2]. However, the quality of library services is often influenced by factors such as infrastructure, availability of collections, staff competence, and literacy programs held. The low interest in reading in Indonesian society is caused by limited access to adequate libraries and low purchasing power for books, which ultimately hinders the development of a culture of literacy [3]. The combination of quality education and optimal library ser-

vices is believed to have a significant impact on increasing the community literacy development index. Research by Kusmana [4] shows that developing a culture of literacy in schools through structured literacy programs can significantly increase students' interest in reading and literacy skills.

The literacy culture development program still has a gap in understanding how library and education service factors simultaneously affect the community literacy development index. Previous studies have focused more on each factor separately without examining the interaction and direct or indirect relationships between these factors [5]. Therefore, this study aims to analyze the relationship between library and education service factors and the community literacy development index using the path analysis method. This method allows mapping of complex causal relationships, so that it can provide a more comprehensive picture of the dynamics that affect community literacy. This research is expected to provide a significant contribution to the development of effective strategies and policies to improve community literacy. Policy makers can design programs that are more integrated and responsive to community literacy needs by
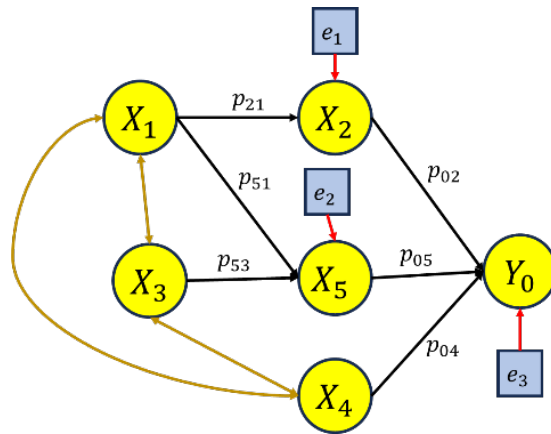
Figure 1. Model Path Analysis

understanding the relationship between library and education services. In addition, the results of this study are expected to be the basis for the development of further, more in-depth research on other supporting factors in literacy development.

2. METHODS

2.1 Statistical Model

In this research Causal Modeling or Path analysis will be used in modeling and analysis. The concept of path analysis has a very long history in statistical application, it was first introduced by Wright [6, 7] and it was first applied in the field of genetics and then developed in the fields of sociology and psychology. Application in genetics can be found in Vogler [8] Warsono et al [9]. Path analysis is modeling that is widely used in social science research [10]. Since then, this method was applied in many fields of studies such as education [11, 12, 13], Sociology and social sciences [14, 15, 16, 17, 18], Business and management [9, 19, 20, 21]. Path analysis is not a method to find a model, but it is a method that can be used for testing causal models which have been proposed by scientists [9, 10, 15]. Therefore, path analysis or causal modeling is a method to test a proposed model offered by researchers [15].

The data used in the path analysis is data from the Central Statistics Agency (BPS) in the form of Community Literacy Development Index (IPLM) data and data on the level of education completion in 2023. There are 6 variables used in the analysis, namely IPML (Y_0), equal distribution of library services (X_1), adequacy of library collections (X_2), ratio of adequacy of library staff (X_3), level of community visits per day (X_4), and level of education completion (X_5). The six variables will be built into the path analysis model as follows:
From Figure 1, the mathematical model is written as follows:

$$\text{Model 1:} \quad X_2 = p_{21}X_1 + p_1e_1 \tag{1}$$

$$\text{Model 2:} \quad X_5 = p_{51}X_1 + p_{53}X_3 + p_2e_2 \tag{2}$$

$$\text{Model 3:} \quad Y_0 = p_{02}X_2 + p_{04}X_4 + p_{05}X_5 + p_3e_3 \tag{3}$$

Where, e_1, e_2, and e_3 are error. Based on the models in Equations (1), (2), and (3), there is a null hypothesis in each model. The null hypothesis of the three models to be observed is:
H_01: There is no direct influence of the level of library service equity on the level of library collection adequacy.
H_02: There is no direct influence of the level of library service equity and the ratio of library staff adequacy on the level of education completion.
H_03: There is no direct influence of the level of library collection adequacy, the level of community visits per day, and the level of education completion on IPML.
pi can be calculated as follows:

$$p_i = \sqrt{1 - R_i^2}, \text{where } i = 1, 2, 3 \tag{4}$$

R_i^2 is the estimated degree of determination models equation (1), (2), and (3) respectively. Furthermore, in addition to direct and indirect effects, the total effect of one variable on another variable will also be calculated. In path analysis, direct effect refers to the direct influence of one variable on another variable without going through an intermediary variable. For example, education directly affects income. Meanwhile, indirect effect occurs when the influence of one variable on another variable passes through one or more intermediary variables. For example, education can affect job choice, which then affects income.

2.2 Decomposition of Correlation

Path analysis improves the understanding of correlation by breaking it down into its component variables. Path analysis can be used to analyze correlations between components, which is an interesting application. The causal model allows to determine the proportion of correlation between two variables that is caused by direct and indirect effects. Data from X_2, X_5, and Y_0 are transformed into standardized data with a mean of 0 and a standard deviation of 1. Therefore, the expected values obtained are as follows:

$E(X_1X_1) = E(X_2X_2) = E(X_3X_3) = E(X_4X_4) = E(X_5X_5) = E(YY)$ = 1

- $E(X_1X_2) = r_{12}$, $E(X_1X_5) = r_{15}$, $E(X_3X_5) = r_{35}$, $E(X_2Y_0) = r_{02}$, $E(X_4Y_0) = r_{04}$, and $E(X_5Y_0) = r_{05}$, where $r_{12}, r_{15}, r_{35}, r_{02}, r_{04}$, and r_{05} are correlation between variable X_1 and X_2, X_1 and X_5, X_3 and X_5, Y_0 and X_2, Y_0 and X_4, and Y_0 and X_5.
- $E(e) = 0$, where e are error.

From model (1), algebra and tracing rule can be used to find the correlation composition. Both sides of model (1) are multiplied by X1 and then the expected value is taken as presented below.

$$E(X_1X_2) = p_{21}E(X_1X_1) + p_1E(e_1)$$
$$r_{12} = p_{21} \tag{5}$$

To find the decomposition of r_{15} and r_{35}, from model in equation (2), both terms is multiply by X_1 and then take the expected value.

$$E(X_1 X_5) = p_{51}E(X_1 X_1) + p_{53}E(X_1 X_3) + 0$$
$$r_{15} = p_{51} + p_{53}r_{13} \tag{6}$$

From model in equation (2), both terms is multiply by X_3 and then take the expected value.

$$E(X_3 X_5) = p_{51}E(X_1 X_3) + p_{53}E(X_3 X_3) + 0$$
$$r_{35} = p_{51}r_{13} + p_{53} \tag{7}$$

To find r_{02}, r_{05}, and r_{04}, from model inequation (3), both term multiply by X_2 and then take the expected value.

$$E(X_2 Y_0) = p_{02}E(X_2 X_2) + p_{05}E(X_2 X_5) + p_{04}E(X_2 X_4)$$
$$r_{02} = p_{02} + p_{05}r_{25} + p_{04}r_{24} \tag{8}$$

From model in equation (3), both term multiply by X_5 and then take the expected value.

$$E(X_5 Y_0) = p_{02}E(X_2 X_5) + p_{05}E(X_5 X_5) + p_{04}E(X_5 X_4)$$
$$r_{05} = p_{02}r_{25} + p_{05} + p_{04}r_{45} \tag{9}$$

From model in equation (3), both term multiply by X_4 and then take the expected value.

$$E(X_4 Y_0) = p_{02}E(X_2 X_4) + p_{05}E(X_4 X_5) + p_{04}E(X_4 X_4)$$
$$r_{04} = p_{02}r_{24} + p_{05}r_{45} + p_{04} \tag{10}$$

3. RESULTS AND DISCUSSION

3.1 Simultaneous, Partial, and Meaningful Tests on a Model

The model in Figure 1 shows a path analysis model represented by variables Y_0, X_1, X_2, X_3, X_4 and X_5 which refer to IPML, library service equity, library collection adequacy, library staff adequacy ratio, community visit rate per day, and education completion rate.

Before analyzing the data using path analysis, the data was transformed into a standard deviation form with the average 0 and the variance 1. The results of the analysis for model in equation (1) are presented in Table 1.

Table 1 presents the analysis of variance for testing the parameters in model (1) with the null hypothesis that there is no direct effect of library service equity on the adequacy of library collections. The result is F-test = 4.89 with p-value = 0.0342. The result shows that the null hypothesis is rejected and we conclude that there is a direct effect of library service equity on the adequacy of library collections. R-square = 0.1326 means that 13.2621% of the variation in the adequacy of library collections can be accounted for by the library service equity or model. Table 2 shows the results of parameter estimation and partial testing of model (1) with p-value = 0.0342. Therefore, the null hypothesis is rejected. The plot image shows the contour of model (1), which also shows a positive correlation. If the value of library service equity increases, the value of library collection
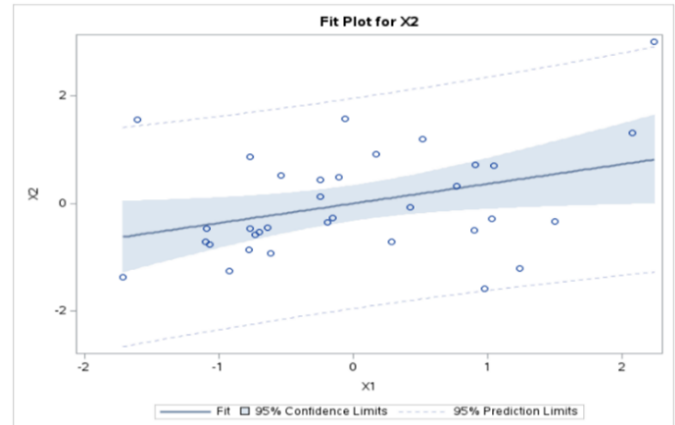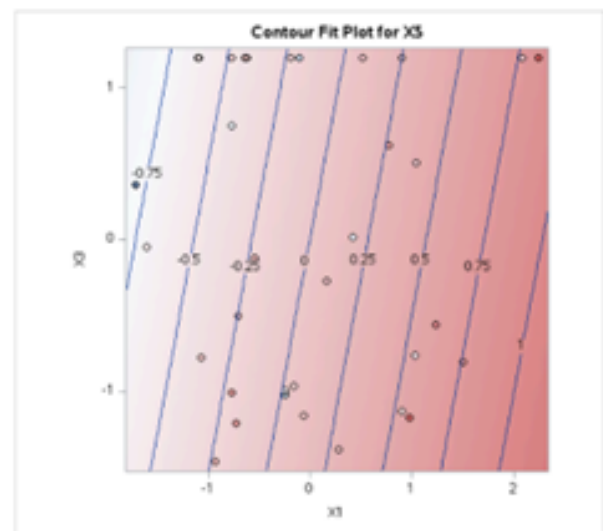

Figure 2. Fit Plot for Model (1)

Figure 3. Fit Plot conour for Model (2)

adequacy increases. The estimation of model (1) is $X_2 = 0.36417$, X_1 with Parameter Error calculate by (4) is $p_1 = \sqrt{1 - RSquare} = \sqrt{1 - 0.1326} = 0.8673$. Table 3 gives the results for model (2).

Table 3 presents the analysis of variance for testing model (2), with the null hypothesis that there is no direct effect of library service equity and library staff adequacy ratio on the level of education completion. The result is F-test = 3.94 with p-value = 0.0298. These results indicate that the null hypothesis is rejected and we conclude that there is a direct effect of library service equity and library staff adequacy ratio on the level of education completion. R-square = 0.202867 means that 20.2867% of the variation in the level of education completion can be accounted for by library service equity and library staff adequacy ratio. Table 4 shows the results of parameter estimation and partial testing of model in equation (2) with p-value = 0.0104 and p-value = 0.4543 respectively. therefore the null hypothesis is rejected, but the null hypothesis is not rejected. Although the partial test

Table 1. Table ANOVA of Model (1)

Source	DF	Sum of Squares	Mean Square	F Value	P-value
Model	1	4.3765	4.3765	4.89	0.0342
Error	32	28.6235	0.8945		
Corrected Total	33	33			
R-Squared = 0.1326					

Table 2. The Estimate of Parameters and Partial Test of the Parameter Model (1)

Parameter	Estimate	Standard Error	t Value	P-value
Intercept	-.0000	0.1622	-0.00	1.0000
X_1	0.3641	0.1646	2.21	0.0342

Table 3. Table ANOVA for Model (2)

Source	DF	Sum of Squares	Mean Square	F Value	P-value
Model	2	6.6946	3.3473	3.94	0.0298
Error	31	26.3053	0.8485		
Corrected Total	33	33			
R-Squared= 0.2028					

Table 4. The Estimate of Parameters and Partial Test of the Parameter Model (2)

Parameter	Estimate	Standard Error	t Value	P-value
Intercept	-.0000	0.1579	-0.00	1.0000
X_1	0.4375	0.1604	2.73	0.0104
X_3	-.1215	0.1604	-0.76	0.4543

Table 5. Table ANOVA for Model (3)

Source	DF	Sum of Squares	Mean Square	F Value	P-value
Model	3	23.1655	7.7218	23.56	<.0001
Error	30	9.8344	0.3278		
Corrected Total	33	33			
R-Squared= 0.7019					

Table 6. The Estimate of Parameters and Partial Test of the Parameter Model (3)

Parameter	Estimate	Standard Error	t Value	P-value
Intercept	-.0000	0.0981	-0.00	1.0000
X_2	0.5963	0.1001	5.96	<.0001
X_4	0.4306	0.1051	4.09	0.0003
X_5	0.2141	0.1048	2.04	0.0501

is not rejected, the absolute value of p_{51} = 0.43752 is greater than 0.05 which indicates that this parameter is significant. Figure 3 shows the contour of model in equation (2), which also shows a negative correlation. If the value of library service equity increases, the value of the level of education completion moves towards red (Figure 3). The response to the level of education completion decreases when the value of library service equity increases, and other variables are held constant. However, the trend is positive when the value of the library staff adequacy ratio increases, the value of the level of education completion moves upwards, indicated by a straight line that increases when the library staff adequacy ratio increases and other variables are held constant. . The estimate of model (2) is X_5= 0.4375x_1-0.1215x_3, and p_5 = $\sqrt{1 - RSquare}$ = $\sqrt{1 - 0.2028}$ = 0.7971. Table 5 displays the results for model (3).

Table 5 presents the analysis of variance for testing model (3), with the null hypothesis that there is no influence of the level of library collection adequacy, the level of community visits per

Table 7. Decomposition of the Correlation between the Distribution of Library Services and the Adequacy of Library Collections given in equation (5) is $r_{12} = p_{21}$

Component	Numerical Quantity	Meaning
p_{21}	0.3641	Because the equalization of library services has a direct effect on the adequacy of library collections
Total (r_{12})	0.3641	Correlation between the equalization of library services and the adequacy of library collections

Table 8. Decomposition of the Correlation between Library Service Equity and Educational Completion Rate given in equation (6) is $r_{35} = p_{51} + p_{53}r_{13}$

Component	Numerical Quantity	Meaning
p_{51}	0.4375	Because the equalization of library services has a direct effect on the level of completion of education
$p_{53}r_{13}$	-0.0038	Because the ratio of library staff adequacy has a direct effect on the level of completion of education and the equalization of library services has a direct effect on the ratio of library staff adequacy.
Total (r_{15})	0.4337	Correlation between the equalization of library services and the level of completion of education

Table 9. Decomposition of the Correlation between the Library Staff Adequacy Ratio and the Level of Educational Completion given in equation (7) is $r_{15} = p_{51}r_{13} + p_{53}$

Component	Numerical Quantity	Meaning
$p_{51}r_{13}$	0.0137	Because the equalization of library services has a direct effect on the level of completion of education and the equalization of library services has a direct effect on the ratio of library staff adequacy
p_{53}	-0.1216	Because the ratio of library staff adequacy has a direct effect on the level of completion of education
Total (r_{35})	-0.1078	Correlation between the ratio of library staff adequacy and the level of completion of education

Table 10. Decomposition of the Correlation between IPML and Library Collection Adequacy given in equation (8) is $r_{02} = p_{02} + p_{05}r_{25} + p_{04}r_{24}$

Component	Numerical Quantity	Meaning
p_{02}	0.5963	Because IPML has a direct effect on the adequacy of library collections
$p_{05}\ r_{25}$	0.0103	Because IPML has a direct effect on the level of completion of education and the adequacy of library collections has a direct effect on the level of completion of education
$p_{04}r_{24}$	0.0380	Because IPML has a direct effect on the level of community visits per day and the adequacy of library collections has a direct effect on the level of community visits per day
Total (r_{02})	0.6447	Correlation between IPML and the adequacy of library collections

day and the level of education completion on IPML. The F-test result = 23.56 with P < 0.0001. These results indicate that the null hypothesis is rejected, so that there is a direct influence of the level of library collection adequacy, the level of community visits per day, and the level of education completion on IPML. The R-squares value = 0.701987, this means that 70.19% of the variation in IPML can be explained by the model. From Table 6, the parameter estimates in model equation (3) are $p_{02} = 0.5963$, $p_{04} = 0.4306$, and $p_{05} = 0.2141$. For the partial parameter test through model in equation (3), the p-value of each variable is lower or equal to 0.05 and the p-value is greater than 0.05. Thus, the estimator that has been found has meaning (meaningfull) [22].

Table 11. Decomposition of the Correlation between IPML and the level of community visits per day given in equation (9) is
$r_{04} = p_{02}r_{24} + p_{05}r_{45} + p_{04}$

Component	Numerical Quantity	Meaning
$p_{02}r_{24}$	0.0526	Because IPML has a direct effect on the adequacy of library collections and the adequacy of library collections has a direct effect on the level of community visits per day
$p_{05}r_{45}$	0.0665	Because IPML has a direct effect on the level of education completion and the level of community visits per day has a direct effect on the level of education completion
p_{04}	0.4306	Because IPML has a direct effect on the level of community visits per day
Total (r_{04})	0.54986	Correlation between IPML and the level of community visits per day

Table 12. Decomposition of the Correlation between HDI and Education Completion Rate given in equation (10) is $r_{05} = p_{02}r_{25} + p_{05} + p_{04}r_{45}$

Component	Numerical Quantity	Meaning
$p_{02}r_{25}$	0.0288	Because IPML has a direct effect on the adequacy of library collections and the adequacy of library collections has a direct effect on the level of completion of education
p_{05}	0.2141	Because IPML has a direct effect on the level of completion of education
$p_{04}r_{45}$	0.1338	Because IPML has a direct effect on the level of community visits per day and the level of community visits per day has a direct effect on the level of completion of education
Total (r_{05})	0.3767	Correlation of IPML and the level of completion of education

3.2 Direct, Indirect, and Total Effects and Correlation Decomposition

The correlation decomposition between the distribution of library services and the adequacy of library collections (r_{12}), the distribution of library services and the level of education completion (r_{15}), the ratio of the adequacy of library personnel and the level of education completion (r_{35}), the IPML and the adequacy of library collections (r_{02}), the IPML and the level of community visits per day (r_{04}), the IPML and the level of education completion (r_{05}), as well as the components and numeric quantities are given in the following Table 7-12.

Figure 4. The Estimation of the Parameter Model Path Analysis

From the model and its equation, how many levels of community visits per day and the level of education completion do we expect from the adequacy of library collections that are 1 standard deviation more than the average library service. From the results of analysis and presented in Figure 4, it is known that if the distribution of library services (X_1) increases by 1 and the library staff adequacy ratio (X_3) is constant, then the level of education completion (X_5) will increase by 0.4375. This is called a direct effect. However, if the distribution of library services (X_1) increases by 1, it results in a change of 0.0314 in the library staff adequacy ratio (X_3). Because each unit change in the library staff adequacy ratio (X_3) in turn results in a change (X_3) of -0.1216 in (X_3) the level of education completion (X_5), a change of 0.0314 in the library staff adequacy ratio (X_3) results in a change of 0.0038 in the level of education completion (X_5). This is called the indirect effect of equalizing library services (X_1).
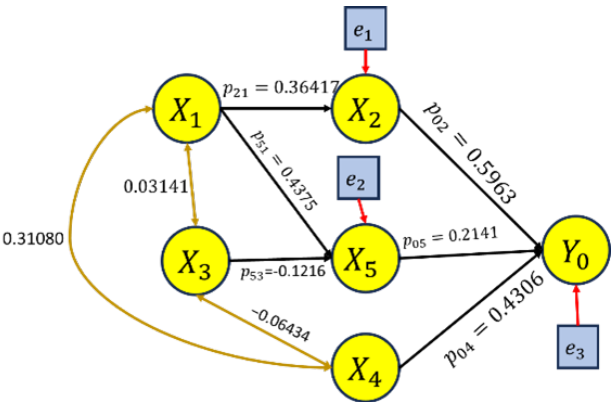
4. CONCLUSIONS

From the discussion above, it is obtained that equalizing library services (X_1) has a significant direct effect on the adequacy of library collections (X_2) with a parameter estimate of $p_{2}1 = 0.3641$. This shows that increasing the equalization of library services will increase the adequacy of library collections. Equalizing library services (X_1) also affects the level of completion of education (X_5) directly $p_{51} = 0.4375$, The ratio of adequacy of library personnel (X_3) has a negative effect on the level of completion of education (p_{53}=-0.1215) although the effect is not significant partially. The level of library collection adequacy (X_2), the level

of community visits per day (X_4), and the level of education completion (X_5) have a direct effect on IPML (Y_0), with parameter estimates of $p_{02} = 0.5963$, $p_{04} = 0.4306$, and $p_{05} = 0.2141$. The distribution of library services (X_1) has an indirect effect on IPML (Y_0) through the level of library collection adequacy (X_2) and the level of education completion (X_5). The total effect shows that the combination of library and education services can explain 70.19% of the variation in IPML.

5. ACKNOWLEDGEMENT

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