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Mathematical Model of Love Dynamics in the Story of the Romantic Legend of the Mandar Tribe

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ABSTRACT

In this study, the mathematical model of love is discussed based on the legend of the Mandar tribe area in West Sulawesi Province. Love is an active action / activity carried out by humans towards other objects, in the form of self-sacrifice, empathy, attention, affection, help, obey words, follow, obey, and want to do whatever the object wants. This study aims to determine the mathematical model for the dynamics of love in the story of two lovebirds contained in the legend of Mandar and determine the equilibrium point and analyze the stability of the mathematical model of their love dynamics so that simulations and interpretations of mathematical models of dynamics can be carried out. Based on the model obtained, it can be known how the dynamics of love that occur between kaco and cicci based on several possible cases that can occur between the two of them. By using maple software, an equilibrium point is obtained consisting of two types of equilibrium points, namely the equilibrium point of the mathematical model of love if there is no struggle from kaco ' and the equilibrium point of the mathematical model of love if there is a struggle from kaco'.

Keyword: Mathematical Model, mandar, Dynamics of Love, legend

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1. Introduction

Love becomes an aspect of life that is difficult and even impossible to eliminate. In fact, in order to understand and understand love, there is no more effective guide than to try to feel it and become an actor of that great instrument. With love making the world more colorful, love makes days feel more precious and not infrequently with love sometimes a smile will appear by itself without any reason that should be behind it (Kaur, 2020). It is untold that there are countless songs that hum verses about love, nor is it undeniable how many poems depart from the sadness and happiness of love, and it would be impossible to count the number of books and writings that raise the topic of love (Baumard *et al*, 2022). Such is love, simple but actually difficult to digest. However, it should be noted that the nature of love will basically never change from the beginning of human creation to the end of the world, at least until the time of modern society today (Laksono, 2022)

The study of the dynamics of love was first initiated by Strogatz with the aim of attracting students in studying lectures on ordinary differential equation systems (Toaha, 2013). Strogatz relates the dynamic properties of a system to a topic that is already on the minds of many students, namely the love story between lovers (Zhao & Guan, 2013). Although the model of love dynamics was originally derived from Strogatz's "pranks" alone, many other researchers later tried to develop the model for more realistic cases. One of the development of the model was carried out by Rinaldi where he took into account the attractiveness factor of the couple.

He developed this model to explain why two people who were initially very different and did not know each other could establish a love relationship (Nura & Syafwan, 2014).

This study discusses more about the study of love based on an approach with the field of mathematical modeling that has also been done by previous researchers. The mathematical model will be made based on one of the legends of the Mandar tribe entitled "The Love Story of Mati Kaco' and Cicci'" (Zuhriah, 2016). In short, this story begins with the Kaco' who is a commoner falling in love with Cicci' a king's daughter. Their love story was not sanctioned by the king so the king did everything possible to separate the two. In the end, because of the great love between the two of them and not wanting to be separated from each other, Cicci' decided to commit suicide after previously killing Kaco' first (Mandarmammis, 2012).

2. Method

This research was conducted using the literature study method by collecting various references in the form of books, journals and other related sources. The model is built on assumptions to limit the problems to be discussed in this study. Furthermore, analysis is carried out on the model that has been formed, namely by determining the equilibrium point and conducting stability analysis (Toaha, 2013). Then, numerical simulations are carried out on the model and the results of the numerical simulations are then interpreted so that it is easier to make conclusions.

3. Result and Discussion

a. *Mathematical Model Formulation*

The formation of a mathematical model of love dynamics in romantic love stories of the Mandar area is made based on the following assumptions:

(i) Kaco' and Cicci' both have an attraction for each other
(ii) The interaction between Kaco' and Cicci' can cause their love for each other to increase
(iii) Kaco' and Cicci' feelings can be damaging to their relationship and lead to aggression
(iv) There was both support and opposition to Kaco's efforts

Based on these assumptions, a mathematical model is obtained as follows

$$\frac{dK}{dt} = \alpha - \beta PK - \pi K \tag{1}$$

$$\frac{dC}{dt} = \gamma + \varepsilon P - \pi C \tag{2}$$

$$\frac{dP}{dt} = \beta PK - \varepsilon P - \pi p \tag{3}$$

The variables and parameters used in constructing a model of love dynamics in the case of polygamy are as listed in Table 1.

Table 1. Model Variables and Parameters

Symbol	Information
K	Great love Kaco' to Cicci'
C	Great love Cicci' to Kaco'
P	Great Love Struggle Kaco' (*Perjuangan Kaco*)/day
α	Great love kaco' because of interest in cicci
β	Kaco response to partner love
π	Natural reduction in love over time
γ	Great love cicci' because of the attraction to kaco'
ε	Increased love cicci see kaco' struggle

b. Equilibrium Point

The equilibrium point is obtained by making the left segment in the system of equations (1)-(3) to zero so that it is obtained

$$0 = \alpha - \beta PK - \pi K \quad (4)$$

$$0 = \gamma + \varepsilon P - \pi C \quad (5)$$

$$0 = \beta PK - \varepsilon P - \pi P \quad (6)$$

By using maple software, an equilibrium point is obtained consisting of two types of equilibrium points, namely the equilibrium point of the mathematical model of love if there is no struggle from kaco ' and the equilibrium point of the mathematical model of love if there is a struggle from kaco'. The two equilibrium points are as follows:

1) Equilibrium Point Without Struggle

$$K = \frac{\alpha}{\pi}$$

$$C = \frac{\gamma}{\pi}$$

$$P = 0$$

2) Equilibrium Point with Struggle

$$K = \frac{\pi + \varepsilon}{\beta}$$

$$C = \frac{\gamma\,\beta\,\pi + \gamma\,\beta\,\varepsilon + \varepsilon\,\alpha\,\beta - \varepsilon^2\,\pi - \varepsilon\,\pi^2}{\beta\,(\pi + \varepsilon)\,\pi}$$

$$P = \frac{\alpha\,\beta - \varepsilon\,\pi - \pi^2}{(\pi + \varepsilon)\,\beta}$$

c. Model Stability Analysis

The next step is to analyze the stability of the equilibrium point obtained earlier. Stable here is defined as a condition where if the equilibrium point is given interference, it will return to equilibrium. To analyze the stability of the equilibrium point, first determine the Jacobi matrix from equation (1)-(3) by using maple software, namely:

$$J = \begin{bmatrix} -\beta P - \pi & 0 & -\beta K \\ 0 & -\pi C & \varepsilon P \\ K & 0 & \beta K - \varepsilon - \pi \end{bmatrix} \tag{7}$$

A mathematical model is said to be stable when all eigenvalues of matrix (7) are negative. Using maple obtained the eigenvalue of matrix (7) as follows:

1) The equilibrium point eigenvalue without struggle

$$-\frac{-\alpha\,\beta + \varepsilon\,\pi + \pi\,\pi}{\pi}$$

$$-\pi$$

$$-\pi$$

2) The eigenvalue of the equilibrium point with the struggle

$$-\pi$$

$$\frac{1}{2}\,\frac{2\,\pi^2 + 2\,\varepsilon\,\pi - 2\,\pi\,\pi - 2\,\varepsilon\,\pi - \alpha\,\beta + \sqrt{-4\,\alpha\,\beta\,\pi^2 - 8\,\alpha\,\beta\,\varepsilon\,\pi + \alpha^2\,\beta^2 + 12\,\varepsilon^2\,\pi^2 + 12\,\varepsilon\,\pi^3 + 4\,\pi^4 + 4\,\varepsilon^3\,\pi - 4\,\varepsilon^2\,\alpha\,\beta}}{\pi + \varepsilon}$$

$$\frac{1}{2}\,\frac{2\,\pi^2 + 2\,\varepsilon\,\pi - 2\,\pi\,\pi - 2\,\varepsilon\,\pi - \alpha\,\beta - \sqrt{-4\,\alpha\,\beta\,\pi^2 - 8\,\alpha\,\beta\,\varepsilon\,\pi + \alpha^2\,\beta^2 + 12\,\varepsilon^2\,\pi^2 + 12\,\varepsilon\,\pi^3 + 4\,\pi^4 + 4\,\varepsilon^3\,\pi - 4\,\varepsilon^2\,\alpha\,\beta}}{\pi + \varepsilon}$$

Based on the eigenvalues obtained from both types of equilibrium points, it can be seen that the equilibrium point without struggle is said to be asymptotic stable because all eigenvalues are negative and the equilibrium point with struggle can also be said to be asymptotic stable because the eigenvalue is negative with certain conditions.

d. Numerical Simulation

Based on numerical simulations using maple software, the simulation results obtained if Kaco 'did not fight for Cicci' love were as follows:

Table 2. Parameter simulation

Symbol	Value (Assumption)
K	0
C	0
P	0
α	0.23
β	0.104
π	0.001
γ	0.04
ε	0.011

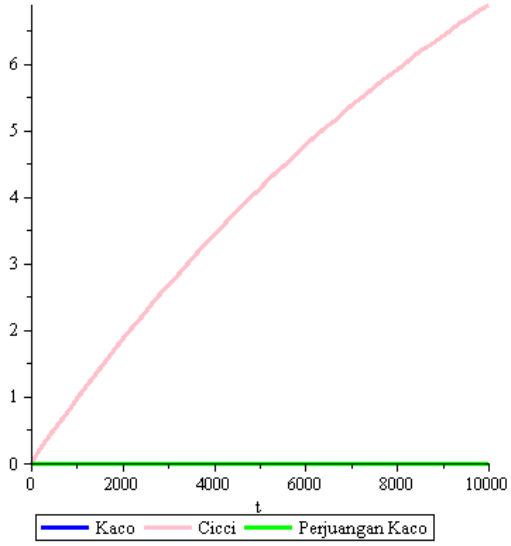

Figure 1. Model Graph of Dynamics of Love without Struggle

Based on figure 1 it is obtained that if Kaco 'does not fight to get Cicci's love', then even though Cicci' also has the same feelings and his love feelings increase over time but at the same time Kaco's love feelings will be constant and tend to disappear over time.

Numerical simulation is also carried out by considering the struggle carried out by Kaco' with the simulation results can be seen in figure (2) below:

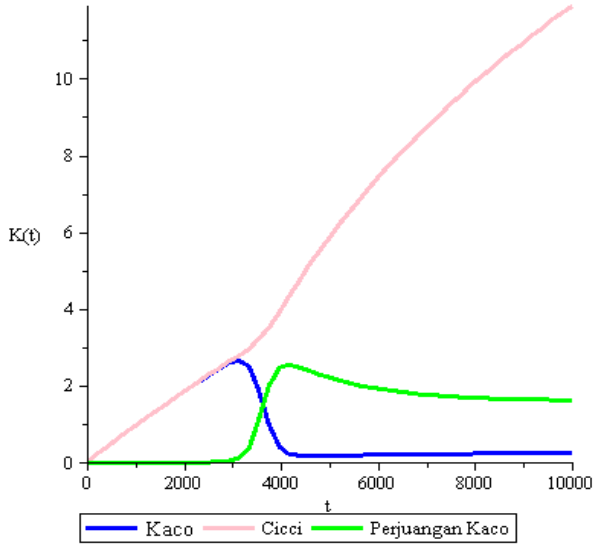

Figure 2. Model Graph of Dynamics of Love without Struggle

Based on figure 2, it is obtained that if Kaco 'struggles to get Cicci's love' then Cicci's love feelings will be much more increased over time than if Kaco' does not struggle. This fact made Cicci's love unstoppable and did everything possible so that she was always with Kaco' so that she finally decided to commit suicide. This simulation can also be a warning to all readers to love and hate something just so as not to be blinded by the feeling of love itself.

4. Conclusion

Based on the simulation results, it was obtained that the struggle of the kaco is very influential in determining the dynamics of love between kaco and cicci. If the kaco struggles, the love of the two of them will increase the same over time, while if the kaco struggles, the love of the caco that initially increases over time, over time it will begin to decrease. On the other hand, cicci's love will continue to increase to a very high level so that anything cicci will do, including suicide, so that his love for kaco is not disturbed by other parties. This simulation can also be a warning to all readers to love and hate something just so as not to be blinded by the feeling of love itself.

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