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An Illustration of *Bilah Keris Luk 7* using Bezier Cubic Curve and Cubic Polynomial Curve

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ABSTRACT

The Bezier cubic curve and cubic polynomial curve are used to illustrate the *bilah keris*, commonly known as a 'blade dagger'. *Keris* is a popular weapon in Malaysia, originally designed for battle. Currently, it has evolved into a conventional craft with aesthetic characteristics. *Keris* has wavy edges known as *luk*, which typically come in odd numbers like three, five, seven, eleven, and thirteen. A *luk* is a curve on a *keris* defined by various equations. Traditionally, each *luk* represents a distinct meaning and symbolism. The *keris luk* 7 represents authority and charisma in government. However, mathematically, this study examined the various curves on the *luk* of the *bilah keris*. Therefore, to study the relationship between the *luk* of a *bilah keris* and its corresponding mathematical equation in order to illustrate the image by using the curves of equation, two distinct equations are applied to create the graphic image for the blade of the *keris* with 7 *luk*. The equations of curves representing different shapes were defined using MAPLE software, and the coordinates were obtained from the GetData Graph Digitizer. The distinctive curve on the *bilah keris* model is determined using mathematical equations, which represent two distinct visualizations of the *keris*. As a result, these eight specific curves demonstrate the flexibility of the curves with the coordinate points acting as the control points on the image. Since this study focuses on the equation of the curve for the *luk* only, researchers can explore a wide range of *keris* designs and corresponding mathematical equations. Mathematical education can utilize the equation-derived design to provide relevant examples in practical contexts.

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1. Introduction

Ethnomathematics is an exploration of the correlation between mathematics and culture, emphasizing the interdependence of mathematics and culture through various mathematical practices and perspectives. This includes integrating culturally relevant content and approaches into mathematics education, whether in formal or informal daily activities. Mathematical applications can be found in daily activities including cooking, building, painting, music, gaming, and customs or rituals. According to [1], mathematics is a symbolizes rationality and represents the pinnacle of human knowledge. A new mathematics education paradigm, ethnomathematics, employs culture as a knowledge system. Nonetheless, integrating ethnomathematics as an alternative pedagogical paradigm into the curriculum demands extra effort.

Ethnomathematics research has significant potential for classroom education and application [1]. Frequently, these activities encompass intricate mathematical principles and problem-solving methodologies. However, Ethnomathematics is not limited to classroom practice, but it can also be found in the arts. As an example, study of ethnomathematics through the art of *kenthongan* music by identifying, describing and analyze mathematical concepts contained in the art [2]. This study shows that there are mathematical concepts found in the art of *kenthongan* music such as concept of geometry, natural numbers, and arithmetic sequences. Furthermore, universal mathematical activities such as counting, locating, measuring, designing, playing, and explaining activities were also found. Despite its broad applications, the study of ethnomathematics within the realm of the arts remains limited, with few explorations into how mathematical concepts are inherently linked to artistic expressions. This study addresses this gap by specifically examining the *keris as* traditional art with mathematical ideas. Through ethnomathematics idea, this study examines the relations of mathematical idea through the equation of curves to represent the *luk* of *bilah keris*. A review of the physical characteristics of the *bilah keris*, particularly the curvature of each *luk*, reveals the presence of certain mathematical relationships, such as the equation of the curve. Through the study, *bilah keris* image is illustrated by using two distinct mathematical formulae to demonstrate that the *luk* of *bilah keris* can be accurately represented by the unique curve of this weapon.

Generally, *keris* is a cultural feature that has been present since ancient times. It was originally designed as a fighting weapon; it has evolved into a traditional craft with artistic characteristics. According to [3], *keris* was primarily employed as a weapon for stabbing adversaries in duels or wars. However, it is important to note that the *keris* possesses more than just utilitarian value, as it also holds artistic, aesthetic, and philosophical significance. It can serve as a tool to aid and direct individuals in navigating societal interactions. Nowadays, *keris* is widely used as a symbol of a ceremony such as a traditional Malay wedding. Physically, *keris* can be divided into two parts which are the blade and the hilt. It has wavy edges known as *luk* that always in odd number such as three, five, seven, eleven and thirteen waves. The uniqueness of the *bilah keris* can be related with many mathematical concepts and this study aims to find out the relationship between mathematics and *bilah keris* through the equation of curves to represent the *luk* of *bilah keris*. This study, however, does not concentrate on examining ethnomathematical concepts. Instead, it aims to articulate the *luk* of the *bilah keris* as an equation of curves. The translation of a *bilah keris* curve into a mathematical curve equation can be observed through the application of mathematics, and it shows that the art is always related to mathematics.

Keris was selected to this study due to its significant historical impact until now. One such example is the *Keris Taming Sari*. *Keris* served as the primary weapon in ancient times, predating the advent of guns like pistols and other similar devices. The distinctiveness of a *bilah keris* arises from the possession of multiple distinct *luk*, which can be ascribed to mathematical computations involving an equation of curves that depict the *luk*. The selected *keris* for this project is the *Keris Melayu Luk 7.* The dimensions of this *keris* are 8 inches and it has 7 *luk*. Hence, this study defined the equations to represent each *luk* by defining it from the cubic polynomial equation and cubic Bezier equation with the coordinates value. The Maple software is used to illustrate an image of *bilah keris*, which includes the equations for the curves of *bilah keris*. Based on the study, it can be concluded that a correlation exists between mathematics and our culture. *Luk* refers to the physical state of a weapon known as *keris,* while mathematically it is referred to as curves. Therefore, this study shows the equations to illustrate the curve for the *luk* of *bilah keris*. Through this study, it can show some benefits for society, particularly for students, as it explores the practical applications of mathematics in real-life scenarios, thus contributing to a more comprehensive understanding of the interplay between culture and mathematics.

2. Literature Review

2.1 Keris and Equation of Curve

Keris is a traditional weapon known for its distinctively sharp edge and elegantly curved shape, embodying both aesthetic and functional qualities. The dimension of *Keris* varies depending on the number of curves or is known as *luk*. Figure 1 presents an example of the features of *keris luk* 7.

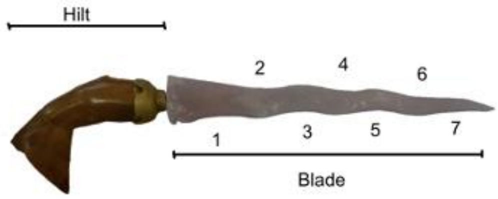


Figure 1. *Keris* with 7 *Luk*

Keris defined as a potent weapon from Malay culture that may be lethal in combat [4]. *Keris* is renowned not just in Malaysia, but also serves as a widely recognized self-defense weapon in the archipelago of Indonesia. UNESCO has designated the Indonesian *keris* as a Masterpiece of The Oral and Intangible Heritage of Humanity [5]. In Indonesia, the blade of a *keris* is known as *Dhapur*. The cultural thoughts provide different perspectives on the *keris*, with Malays seeing them as talismans, Javanese as *'tosan aji'*, and Bugis as *'polo bessi'*. *Keris* designed as a self-defense tool, is intentionally short and unique for use as a weapon, in contrast with another Malay weaponry like swords. The unique thought behind the creation of the *keris* is the defining aspect of this traditional weapon. It is a well-known Malay legacy that arose from the greatest technological advances in ancient Malay culture. In [6], stated this becomes the primary concern in the preservation of historical Malay artefacts, especially *keris,* a traditional Malay weapon. *Keris* not only serves as a weapon, but it also represents sovereignty, dignity, and social position, making it one of the most prized Malay possessions. *Keris* holds a prominent status in Malay society due to its functionality, philosophical significance, and aesthetic appeal [7].

To preserve and emphasize the uniqueness of characteristics of the *keris*, multiple investigations are conducted across different disciplines. Previously, a study utilized the Otsu and Momen Hu techniques to categorize the types of *keris* depending on the number of *luk* [5]. As a result, this method is regarded as a means to differentiate between various types of *keris*. While [8] conducted a study on *keris*, focusing on its model in web semantic applications. They have utilized semantic components, specifically Web Language (OWL), commonly employed in philosophical writing. The *keris* philosophy represents the knowledge derived from the domain of *keris*, presented in a clear and tangible manner, with the purpose of disseminating information and knowledge pertaining to Javanese *keris*. In order to further explore the study of *keris* in other disciplines, it is evident that *keris luk* 7 exhibits a mathematical relation through the curvature of the *bilah keris*, known as *luk*. Mathematical formulae are established for every curve of *luk.*

The Bezier cubic curve and cubic polynomial curve are used to illustrate the *bilah keris* image in this study, which is looking for the mathematical equation that represents the *bilah keris luk*. A Bezier curve is a parametric curve that is commonly used in computer graphics and other fields. A smooth, continuous curve is defined by a set of discrete control points using a formula. Typically, the curve is used to approximate a real-world shape that lacks mathematical representations or whose representation is unknown or too complicated. A curve can be represented by using four control points which is P_0 as the initial point and P_3 as the ending point, defined by equation (1) and depicted in Figure 2. P_1 and P_2 are two additional control points that influence the shape of the curve, used to smooth curves that can be scaled. t is the parameter that is defined on the range between 0 and 1 that indicates the position of the curves.

$$B(t)=(1-t)^3 P_0+3(1-t)^2 tP_1+3(1-t)t^2P_2+t^3P_3, \quad t\in[0,1] \tag{1}$$

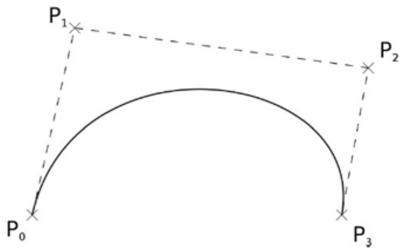


Figure 2. Bezier Curves with four control points

In this paper, different equations are used to determine the curves representing the *bilah keris* image, which is a third-degree polynomial function. The cubic function, also known as third-degree polynomial function is selected based on its simplicity, familiarity, and ease of reference for users in any model. The general form of cubic polynomial equation can be defined as equation (2).

$$f(x) = ax^3 + bx^2 + cx + d \tag{2}$$

Note that $a \neq 0$ and a, b, c are coefficients, and d is the constant, all of them are real numbers. These two general equations are used to generate a model or to illustrate the image for *bilah keris* through the specific equations of curve with the data in form of coordinates. The coordinates are required to define the various equations that correspond to the various *luk* curves. A cubic Bezier curve is defined by four points which are two anchor points (start, P_0, and end points, P_3) and two control points, P_1 and P_3. While to define cubic polynomial curve, three points are needed.

2.2 Bezier Cubic Curve

Equation form of the cubic Bezier *B(t)* can be expressed as equation (1) with four controlling points in Cartesian coordinates. A Bezier curve is significant with its control points. When control points are given, the Bezier curve can be written using De Casteljau's algorithm. Bezier curves are important subset of the curves. Computer-aided geometric design (CAGD) and numerous other fields have employed Bezier curves. The control points are specifically established for each Bezier curve. The most well-liked areas of research in CAGD utilise form control parameters to create Bezier curves. The control points of a Bezier curve and surface can be determined to be linearly related. A Bezier curve is established by the control points, as is well known from the relevant literature.

The flexibility of cubic Bezier equation makes it unique because its curvature is easily controlled by the control points and tangent line. Based on [9], there are two requirements that must be matched to get the smooth path of the curves which are start point and finish point must be the two endpoints of the curve, and the curve must be tangential to the corresponding given directions at the start point and finish point. Bezier's characteristic can make it simple to fulfil these requirements. The curve will always start at P_0 and end at P_3. The curve can be applied smoothly to connect the two ways point generated by setting P_0 and P_3 coordinates as the start and ending points and by setting vertex to the required directions. Hence, to use this Bezier equation to find the *bilah keris* curve equation, the coordinates are identified to fulfil the requirements that can give smooth curves of the *bilah keris*. Control points and tangent line of cubic Bezier curve will give the smoothness of curve for *bilah keris* model. To guarantee the smoothness of curve, the control point at which two curves meet must be on the line between the two control points on either side [10].

The natural smoothness of the curves renders it a viable option for practical applications in real-world scenarios. The utilisation of cubic Bezier curves is prevalent in various practical domains, particularly within the realms of computer graphics, design, animation, and engineering. The cubic Bezier curve has application in various domains of graphic design, including animation. Bezier curves are employed in animation software to generate motion trajectories for characters and objects. Animators are enabled to generate seamless and authentic movements that appear natural as time progresses. In animation applications, such as Adobe Flash and Synfig, Bezier curves are used to outline, for example, movement. Users outline the wanted path in Bezier curves, and the application creates the needed frames for the object to move along the path. For *3D* animation, Bezier curves are often used to define 3D paths as well as 2D curves for key frame interpolation. According to [11], because of their simple formulation, excellent geometric features, and widespread use in science, engineering, and computer-based engineering design, Bezier curves with Bernstein basis functions are well recognised, particularly cubic Bezier curves. Hence, because of the characteristics, smoothness and the flexibility of the curves, the equation of Bezier curves is used to formulate the curve to illustrate the image of the *bilah keris.*

2.3 Cubic Polynomial Curve

The study and comprehension of cubic polynomial equations have undergone substantial advancements throughout history. Involving the collaborative efforts of mathematicians from diverse cultures and historical eras. A cubic polynomial function is a type of polynomial function with the highest power of the variable typically denoted as x (equation (2)) being 3. The graphical representation of a cubic function generally has a curvature featuring one or more inflection points. The curve can display a variety of shapes, including upward and downward curves, depending on the values of the coefficients. However, a curve segment cannot interpolate through two defined endpoints with stated derivatives at each endpoint in a lower degree representation. The unknown coefficients are calculated using initial-end conditions and equating the first and second derivatives of both polynomials [12] such as presented in Figure 3. Cubic splines are polynomials of degree three joined together at a few knots. The cubic polynomial approach is widely used in serial and parallel mechanisms, which can provide vibration limitation and increase overshooting.

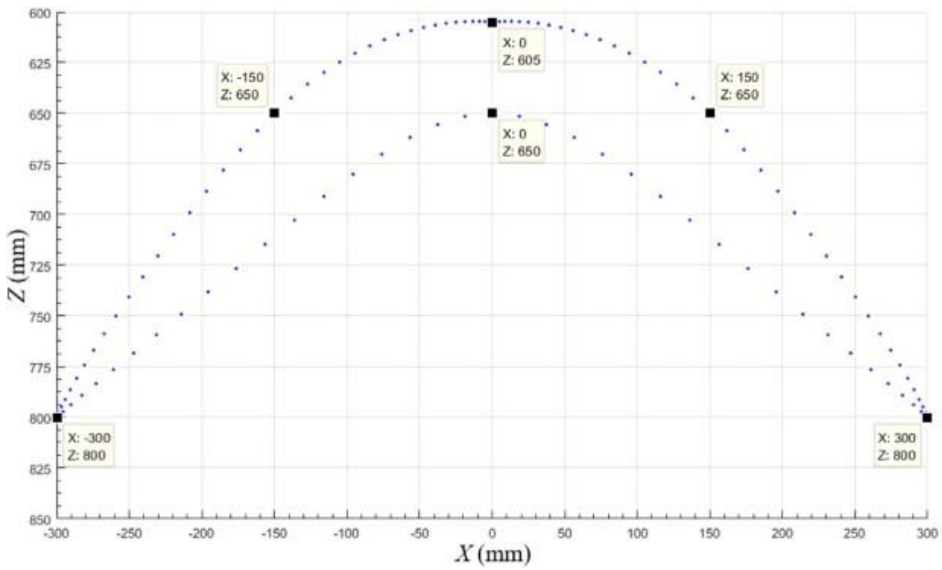


Figure 3. Trajectory Planning by Cubic Polynomials

Based on Figure 3, the curve is formed by the coordinates that lie on the curve and define the equation. Knowing the specific coordinates, the equation is defined by using the general equation of a cubic polynomial and coordinates. Through the coordinates, the cubic equation can be solved to form a particular equation. It is important to note that the coordinates can form a particular cubic equation, and the roots of a cubic polynomial equation are the values of the variable that satisfy the equation, making it equal to zero. Tiruneh in his study introduced an alternative approach to solving the cubic and quartic polynomial equation by study utilized an analogous polynomial substitution method that is more intuitive and straightforward compared to standard formulations [13]. The alternative formula is easy to formulate and solve and provides a more intuitive basis for understanding and solving polynomial equations.

The evolution of the cubic equation is not only in terms of theory and concept but is also affected by the application. These methods have found applications in diverse fields, including engineering, physics, economics, and more. In [14], he creates a surrogate model using cubic polynomials to predict the performance of a high temperature rising combustor in aeroengines. This equation is chosen because of its versatility and the simplicity of curve fitting. When fitting a model to data points, cubic polynomials often provide a better fit than lower-order polynomials, especially when the relationship between variables is moderately complex. In the study on cubic equation applications in engineering as in [15], they found that cubic equations are the most accurate and simple equations of states for real gases within a narrow temperature and pressure range. In general, the advancement of techniques for solving cubic equations has had a significant influence on mathematics and its practical use in real-life scenarios.

3. Methodology

3.1 Representation of the *Bilah Keris* in Cartesian Coordinate

The *bilah keris* image is illustrated by defining the real data based on the image's coordinates using a GetData Graph Digitizer (refer Figure 4). The equations for the curve of *luk* for the *bilah keris* are defined by dividing the lengths *p, q, r*, and *s* in the vertical position parallel to each location on the left and right curves of the *bilah keris*.

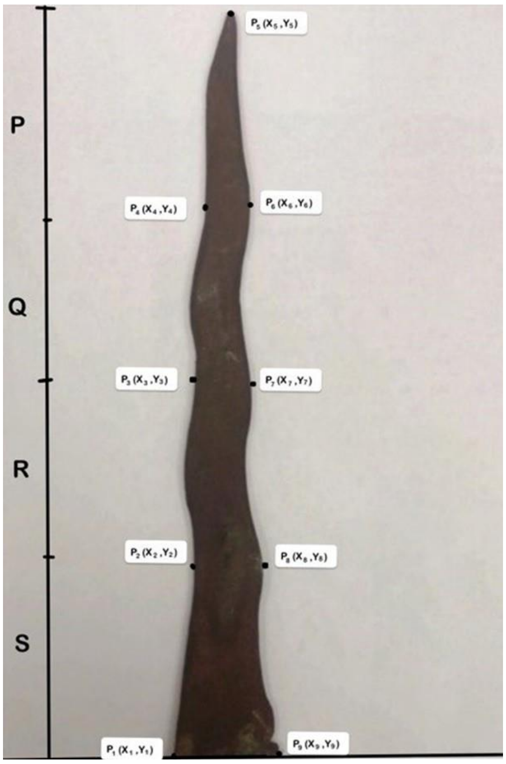


Figure 4. Position of curves and coordinates of the actual *Bilah Keris*

Each partition has a starting and ending point used to define eight different curves. $f_1(x), f_2(x), f_3(x), f_4(x), g_1(x), g_2(x), g_3(x)$ and $g_4(x)$ are the equations defined for each curve of *luk* from different points of two-dimensional coordinate: $p_1, p_2, p_3, p_4, p_5, p_6, p_7, p_8,$ and p_9. The data is collected by using online software called GetData Graph Digitizer. The data are collected according to the vertical position of the *bilah keris*. The coordinates recorded for every section include the starting point, ending point, and two points of intermediate positions (refer Figure 5). The general equation of the cubic polynomial and the cubic Bezier curve are both defined by applying these points. Note that each *luk* is represented by a distinct equation that is determined by the specific position of the points.

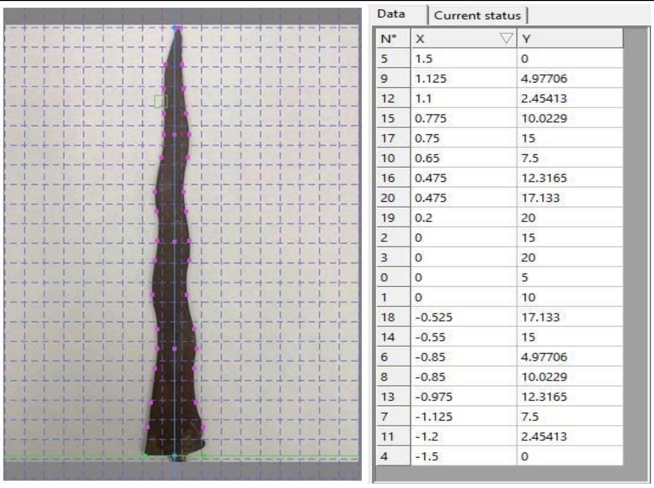


Figure 5. *Bilah Keris* on GetData Digitizer with point of *x* and *y* axis

Based on specific points defined on the *x* and *y* axes, the values of coordinates representing the points on the curve of the *bilah keris* are recorded and listed in Table 1.

Table 1. Coordinate of *Bilah Keris*

Part of Curves	Left side of curves		Right side of curves	
S	P_1	(-1.500,0.000)	P_9	(1.500,0.000)
	x_1	(-1.350,1.307)	x_3	(1.450,1.307)
	x_2	(-1.200,2.454)	x_4	(1.000,4.059)
	P_2	(-0.850,5.000)	P_8	(1.125,5.000)
R	P_2	(-0.850,5.000)	P_8	(1.125,5.000)
	x_5	(-0.875,5.896)	x_7	(1.025,5.895)
	x_6	(-1.000,9.106)	x_8	(0.750,9.106)
	P_3	(-0.849,10.000)	P_7	(0.775,10.000)
Q	P_3	(-0.849,10.000)	P_7	(0.775,10.000)
	x_9	(-0.900,11.399)	x_{11}	(0.575,11.399)
	x_{10}	(-0.675,13.922)	x_{12}	(0.675,13.922)
	P_4	(-0.550,15.000)	P_6	(0.750,15.000)
P	P_4	(-0.550,15.000)	P_6	(0.750,15.000)
	x_{13}	(-0.525,15.986)	x_{15}	(0.600,15.986)
	x_{14}	(-0.450,18.280)	x_{16}	(0.375,18.280)
	P_5	(0.200,20.000)	P_5	(0.200,20.000)

Table 1 presents the coordinates derived from the actual image of the *bilah keris* using the GetData Graph Digitizer. Obtaining an exact measurement is crucial to guarantee that the resulting equation can produce an identical dagger blade image.

3.3 Particular Equation of *Luk*.

The *bilah keris* curve in Figure 4 are segmented into eight parts: four curves for the right side and four curves for the left side. Note that the curvature on the left and right sides of the *keris* is not symmetrical, so each curvature needs to be determined separately. The cubic Bezier equation (1) and cubic polynomial equation (2) are implemented to the data in Table 1. Maple software is used to derive the particular equation for each curve. An image illustrating the *bilah keris* is created based on the curve equation.

4. Results and Discussion

This section provides the equation of the curve for the *luk* of the *bilah keris*, which is derived from the cubic Bezier equation and cubic polynomial equations. The image was generated as well using MAPLE software as an extension of the generated equation.

4.1 The Equation and Illustration of *Bilah Keris* Image

A complete representation of *bilah keris* necessitates the utilization of eight equations. The mathematical expressions $f_1(x), f_2(x), f_3(x), f_4(x), g_1(x), g_2(x), g_3(x)$ and $g_4(x)$ of *bilah keris* are derived through the Maple software with the coordinates point from Table 1. Then, the image of *bilah keris* is made based on the equations of curves. Table 2 and Figure 6 show the results obtained from equation (1), cubic Bezier curve. While Table 3 and Figure 7 show the equations of curves and image of *bilah keris* derived by the cubic polynomial curve equation. The equation represented by the Bezier curve for the *luk* of *bilah keris* is defined as a parametric equation with the variable *t*.

Table 2. Equation of Cubic Bezier Curves of *Bilah Keris*

Curve	Equation of Cubic Bezier curves
$f_1(y)$	$f_x = -1.500(1-t)^3 - 4.050(1-t)^2 t - 2.925(1-t)t^2 - 0.850t^3$ $f_y = 3.921(1-t)^2 t + 12.177(1-t)t^2 + 5.000t^3$
$f_2(y)$	$f_x = -0.850(1-t)^3 - 2.625(1-t)^2 t - 3.000(1-t)t^2 - 0.849t^3$ $f_y = 5.000(1-t)^3 + 17.688(1-t)^2 t + 27.318(1-t)t^2 + 10.000t^3$
$f_3(y)$	$f_x = -0.849(1-t)^3 - 2.700(1-t)^2 t - 2.025(1-t)t^2 - 0.550t^3$ $f_y = 15.000(1-t)^3 + 34.197(1-t)^2 t + 41.766(1-t)t^2 + 15.000t^3$
$f_4(y)$	$f_x = -0.550(1-t)^3 - 1.575(1-t)^2 t - 1.350(1-t)t^2 + 0.200t^3$ $f_y = 15.000(1-t)^3 + 47.958(1-t)^2 t + 54.840(1-t)t^2 + 20.000t^3$
$g_1(y)$	$g_x = 1.500(1-t)^3 + 4.350(1-t)^2 t + 3.000(1-t)t^2 + 1.125t^3$ $g_y = 3.921(1-t)^2 t + 12.177(1-t)t^2 + 5.000t^3$
$g_2(y)$	$g_x = 1.125(1-t)^3 + 3.075(1-t)^2 t + 2.250(1-t)t^2 + 0.775t^3$ $g_y = 5.000(1-t)^3 + 17.685(1-t)^2 t + 27.318(1-t)t^2 + 10.000t^3$
$g_3(y)$	$g_x = 0.775(1-t)^3 + 1.725(1-t)^2 t + 2.025(1-t)t^2 + 0.750t^3$ $g_y = 10.000(1-t)^3 + 34.197(1-t)^2 t + 34.197(1-t)t^2 + 15.000t^3$
$g_4(y)$	$g_x = 0.750(1-t)^3 + 1.800(1-t)^2 t + 1.125(1-t)t^2 + 0.200t^3$ $g_y = 15.000(1-t)^3 + 47.958(1-t)^2 t + 54.840(1-t)t^2 + 20.000t^3$

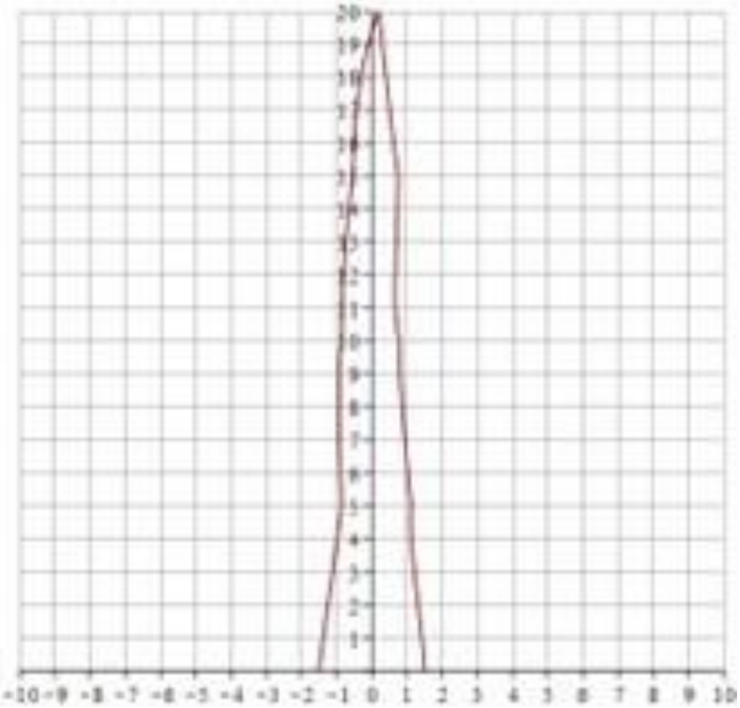


Figure 6. An image of a *Bilah Keris* made with the particular equation of Bezier Cubic Curve

Table 3. Equation of Cubic Polynomial Curves of *Bilah Keris*

Curve	Equation of Cubic Polynomial curves
$f_1(y)$	$0.01006734963y^2 - 0.0009421946577y^3 + 0.1032181183y - 1.500000000$
$f_2(y)$	$-0.2160414819y^2 + 0.01066658191y^3 + 1.374170395y - 3.653137667$
$f_3(y)$	$0.2057948088y^2 - 0.004919498937y^3 - 2.748308225y + 10.97410031$
$f_4(y)$	$-0.8231132152y^2 + 0.01675294763y^3 + 13.46248598y - 73.82801448$
$g_1(y)$	$-0.1501014004y^2 + 0.02222160193y^3 + 0.1199669541y + 1.500000000$
$g_2(y)$	$-0.07893661256y^2 + 0.004264307889y^3 + 0.3677953079y + 0.7264002886$
$g_3(y)$	$0.3167107389y^2 - 0.007648544326y^3 - 4.289709918y + 19.64956961$
$g_4(y)$	$0.1878288308y^2 - 0.003478074594y^3 - 3.466790079y + 22.22886601$

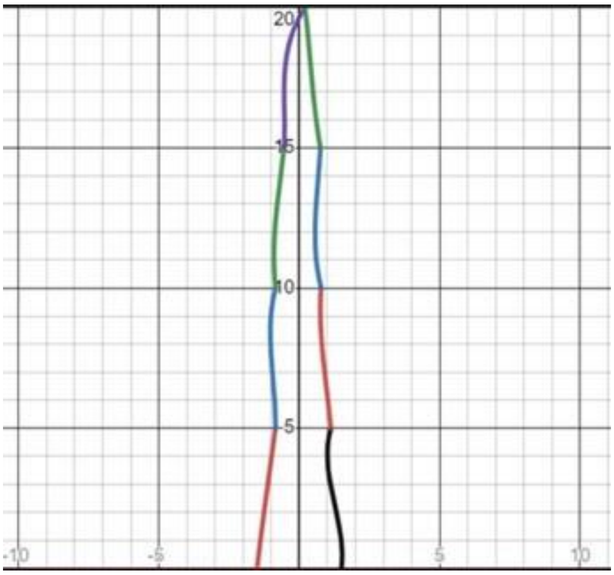


Figure 7. An image of a *Bilah Keris* made with the particular equation of Cubic Polynomial Curve

The equations $f_1(x), f_2(x), f_3(x), f_4(x), g_1(x), g_2(x), g_3(x)$ and $g_4(x)$ of *bilah keris* were derived using Maple software. The equation is determined by utilizing coordinate values where *x* is known as the roots of a function and a *y*-intercept value. The equation representing the curve of the *bilah keris* is defined with *x* as the dependent variable and *y* as the independent variable. The *bilah keris* is positioned vertically at the specified coordinate location affects the definition of the equation. However, the Bezier curve is defined in the form of a parametric equation where the variable *t* is defined for the ranges between 0 to 1. Subsequently, all the curves are merged to create a model that is an image of *bilah keris*. Generated images have equal length and width based on the coordinates derived from the data corresponding to the real size of the *bilah keris*. Hence, the final image's dimensions are similar, but the curves for each *luk* are different. Note that each *luk* is represented by a distinct equation that is determined by the specific position of the points. The points recorded from GetData Digitizer give effect to the equation of the published curve. Therefore, the inherent uncertainty in the placement of control points and the approximation on the actual image leads to the inaccuracy of equation and also to the illustrated image. Figure 8 depicts the image of actual *bilah keris* in relation to the Cubic Bezier Image and Cubic Polynomial Image.

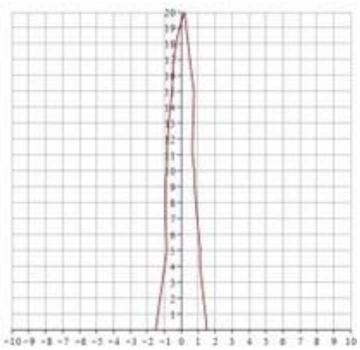
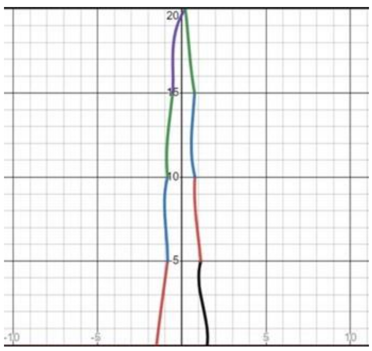
Actual image	**Cubic Bezier Image**	**Cubic Polynomial Image**
		

Figure 8. Image of actual *Bilah Keris*, Cubic Bezier, and Cubic Polynomial

Based on Figure 8, it is obvious that a distinction exists among the depicted images. Identifying the identical image to the actual *keris* is an impossible task that cannot be accomplished through mere observation. Subsequent investigation is required to verify the precise resemblance and subsequently generate an identical image to the original *bilah keris*.

5. Conclusion and Recommendation

This work applied cubic Bezier curves and cubic polynomials to generate the curves, which was then used to illustrate an image of a *bilah keris*. The equation's flexibility depends on the coordinates where the curves are determined by the control points of curves. However, the equations can be enhanced by guaranteeing that the unique features of each curve can be accurately tracked.

In conclusion, the equations of eight curves representing the *bilah keris 7 luk* were defined, although some improvements are necessary. The optimal curve must be identified to establish the equation representing the *bilah keris*. Several curve equations, including Hermite curve, higher-degree polynomial equations, and trigonometric equations, can be applied to get the best fitted curves. Furthermore, the gap between the illustration model and the actual model can be identified to verify the accuracy of the curve equation. Furthermore, the precision of measuring the exact length and width needs enhancement to ensure the data collected is more precise.

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Conflict of Interest

The authors declare no conflict of interest in the subject matter or materials discussed in this manuscript.

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