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Forecasting System For Increasing Crime At The Binjai City Police Station With The Application Of The Website-Based Exponential Smoothing Method

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Abstract

Binjai City is the closest city to the city of Medan, which is the heart of North Sumatra. As one of the closest cities to the city gate of Medan, there are many activities that require a lot of activities. In Binjai City there is a Binjai City Police Office which is located Jl. Sultan Hasanuddin No.1, Binjai City, North Sumatra. Based on crime data at the Binjai City Police Station, it shows that crime that occurs every day is constantly increasing. This is because several factors influence it, namely internal factors within oneself such as having a realistic mindset and so on while external factors such as economic level factors or low education levels that have an impact on the difficulty of finding jobs, uneven population density, very minimal salaries, urgent needs, supportive environmental situations, social inequality trigger envy and resentment, environmental associations that require costs and so on. When people are faced with such a situation, the thing that will come to their mind is how to get money to meet the needs of their families at all costs. So that it affects one's mentality and actions to commit criminal acts.Exponential smoothing method is a procedure that continuously improves forecasting with the average (smoothing = smoothing) past values of a time sequence data with. The Exponential smoothing method is a development of the Moving Averages method.

Keywords*: *Forecasting, Increasing crime, Based Exponential Smoothing

1. Introduction

Crime or criminality is an antisocial act that violates the law, is related to depriving others of property rights and can cause harm, discomfort, and impropriety in society [10]. This can cause various kinds of losses for someone who is a victim, both in terms of material (economic) and immaterial such as the loss of security, comfort, and peace in community life [4]. Crime can arise because it is caused by various factors, namely personal factors, social factors, and situational factors that encourage perpetrators to commit crimes, in other words environmental factors are very influential.Binjai City is the closest city to the city of Medan, which is the heart of North Sumatra. As one of the closest cities to the city gate of Medan, there are many activities that require a lot of activities. In Binjai City there is a Binjai City Police Office which is located Jl. Sultan Hasanuddin No.1, Binjai City, North Sumatra. Based on crime data at the Binjai City Police Station, it shows that crime that occurs every day is constantly increasing. This is because several factors influence it, namely internal factors within oneself such as having a realistic mindset and so on while external factors such as economic level factors or low education levels that have an impact on the difficulty of finding jobs, uneven population density, very minimal salaries, urgent needs, supportive environmental situations, social inequality trigger envy and resentment, environmental associations that require costs and so on [1]. When people are faced with such a situation, the thing that will come to their mind is how to get money to meet the needs of their families at all costs. So that it affects one's mentality and actions to commit criminal acts.Exponential smoothing method is a procedure that continuously improves forecasting with the average (smoothing = smoothing) past values of a time sequence data with. The Exponential smoothing method is a development of the Moving Averages method.

2. Research Methods

2.1 System Definition

"A system is a group of integrated elements with the same goal to achieve a goal." A system is a collection of objects such as people, resources, concepts and procedures to perform a function or purpose. The system is divided into three parts, namely input, process and output. "The parts are surrounded and always include a feedback mechanism." [5]

2.2 System Classification

The system is a form of integration between one component and another. Because the system has different goals for each case, the system can be classified into several points of view, namely: [6]

1. Abstract system: a system of thoughts or ideas that are not physically visible (theological system).
2. Physical system: is a system that exists physically (computer system, accounting system, production system).
3. Natural systems: systems that occur through natural processes. (solar system, space system, reproductive system.
4. Man-made systems: systems designed by humans. Man-made systems that involve human-machine interaction are called human machine systems (e.g. information systems)
5. Deterministic system: operates with predictable behavior. The interaction of its parts can be detected with certainty so that the output of the system can be predicted (example: computer system)
6. Probabilistic system: a system whose future conditions cannot be predicted because it contains elements of probability.
7. Close system: a system that is unrelated and unaffected by its external system. This system works automatically without any interference from outside parties. Theoretically such systems exist, but in reality there is no truly closed system, only relatively closed systems.
8. Open system: a system that is related to and affected by its external environment. More specifically, it is also known as an automated system: which is part of a man-made system and interacts with control by one or more computers as part of the system used in modern society.

2.3 Forecasting

Forecasting is very important for every organization, because this will be the basis for making management decisions which will certainly affect organizational development [7]. The forecasting method serves to predict time series data for several future periods based on data from several previous periods. Forecasting is predicting future events using previous data (historical data) which will later be the basis for decision making. [2] To do forecasting, certain methods are needed and which method is used depends on the data and information to be predicted and the goals to be achieved. In practice there are various forecasting methods among others [3].

1. Forecasting based on time periods.
   Forecasting based on time span is divided into 3, namely:
   a. Short-term forecasting is the time period for forecasting less than one year, generally less than three months, usually used for purchasing plans, work scheduling, number of kindergartens, production levels.
   b. Medium-term forecasting is a timeframe for forecasting three months to 18 months, usually used for planning 9 sales, planning and budgeting production and analyzing various operating plans.
   c. Long-term forecasting is a timeframe for forecasting three years or more, typically used for planning new products, capital budgeting, facility locations, or expansion and research and development.
2. Forecasting by method/approach
   Forecasting based on the method is divided into 2, namely:
   a. The qualitative forecasting method, qualitative dementia, is forecasting based on qualitative data in the past. The results of the forecasts made depend largely on the person who compiled them. Qualitative methods can be divided into explanatory and normative methods.
   b. The quantitative forecasting method, namely quantitative crime, is a forecast based on quantitative data in the past. The results of forecasting made are very dependent on the method used in forecasting. Quantitative methods are divided into 2, namely periodic series (Time Series) and causal methods.

2.4 Forecasting Steps

Good forecasting is forecasting that is done by following good drafting steps or procedures. According to Gaspersz in the research of there are 9 steps that must be considered to ensure the effectiveness and efficiency of the forecasting system, namely:

1. Determining the purpose of forecasting
2. Choose an independent demand item to forecast
3. Determine the time horizon of forecasting (short, medium, or long term)
4. Selecting forecasting models
5. Obtain the data needed to perform forecasting
6. Forecast model validation
7. Make forecasts
8. Implementation of forecasting results
9. Monitor the reliability of forecasting results

2.5 Demand forecasting methods

Many types of forecasting methods are available for use, but more important is how to understand the characteristics of a forecasting method to be suitable to be applied to the case under study based on data that has occurred previously. In general, forecasting methods can be divided into two main categories, namely quantitative methods and qualitative methods. Quantitative methods can be divided into periodic series or time series and causal methods, while qualitative methods can be divided into exploratory and normative methods [8].

Quantitative methods are very diverse and each technique has certain properties, precision and costs that must be considered in choosing a particular method. To use quantitative methods there are three conditions that must be met, namely:

Information about the past is available
1. The information can be quantified in numeric form
2. It is assumed that some past patterns will continue Forecasting demand is the level of demand for products that are expected to be realized for a certain period of time in the future.

According to [8], there are seven basic stages in doing demand forecasting:
1. Determine the use of forecasting.
2. Choose the items or quantity to be forecasted.
3. Determine the horizon of forecasting.
4. Choosing a forecasting model.
5. Collect the necessary data to obtain knowledge.
6. Doing forecasting.
7. Validate forecasting and implement forecasting results.

2.6 Exponential Smoothing Method

This method is used for short-term forecasting. The model assumes that the data fluctuates around a fixed mean value, with no consistent trends or growth patterns. Unlike moving averages, exponential smoothing places greater emphasis on the current time series through the use of a smoothing constant. The smoothing constant may range from 0 to 1. Values close to 1 place the greatest emphasis on the current value while values close to 0 place emphasis on data points previously [8].

$$Ft = Ft - 1 + \alpha\ (At - 1 - Ft - 1) \quad (1)$$

information:
Ft = new forecasting. Ft-1 = previous forecasting.
α = smoothing constant ($0 \leq \alpha \leq 1$)
At-1 = actual demand for the past period Single Exponential smoothing that has been adjusted to the trend is called Double Exponential Smoothing.

$$F(0)\ =\ F1\ (0)\ =\ A(1) \quad (2)$$

$$F(t)\ =\ \alpha\ A(t)\ +\ (1\ -\ \alpha\ )\ F(t\ -\ 1) \quad (3)$$

$$1\ F\ (t) =\ \alpha\ F(t)\ +\ (1\ -\ \alpha\ )\ F1\ (t\ -\ 1) \quad (4)$$

$$f(t\ +\ \tau\ )\ =\ F1\ (t) \quad (5)$$

Doble exponential smoothing can be described mathematically as follows:
Information:
Ft = forecasting double exponential smoothing in period t
At = forecasting single exponential smoothing in period t
Ft-1 = forecasting double exponential smoothing in period t-1
α = smoothing constant ($0 \leq \alpha \leq 1$)

3. Results And Discussion

3.1 Research Supporting Data

The data consists of the type of crime and the year the crime occurred starting from 2016-2022. The data has been created into a table as follows:

Tabel 1: Number of Of Criminal Case Reported at Police Office in Binjai Municipality, 2016-2022

No.	Types of Crimes	2016	2017	2018	2019	2020	2021	2022
1.	Public Order	-	1	-	-	-	-	-
2.	Combustion	3	7	4	3	5	1	6
3.	Fire	4	9	-	7	2	6	7
4.	Bribery	-	-	-	-	-	-	-
5.	Currency	-	1	2	-	-	-	1
6.	Narcotic	166	123	106	132	259	174	180
7.	Decency	80	71	49	48	45	50	41
8.	Rape	6	3	2	3	1	1	1
9.	Gambling	140	117	103	120	89	98	23
10.	Murder	8	6	3	4	2	1	3
11.	Severe Persecution	228	168	146	146	137	155	126
12.	Minor abuse	81	120	118	96	76	55	55

13.	Theft by incrimination	269	204	174	213	204	178	241
14.	Common Theft	46	69	55	62	62	35	41
15.	Violent Theft	42	28	32	27	27	35	28
16.	Ranmor Theft	210	142	151	170	170	142	132
17.	Extortion	6	6	10	6	6	9	6
18.	Embezzlement	87	102	101	102	102	115	126
19.	Deceit	117	74	105	132	132	101	124
20.	Destruction	45	37	30	27	27	26	30
21.	Procurement	2	1	-	1	1	1	-
22.	Adultery	2	1	6	6	6	4	5
23.	Mail Forgery	5	2	-	2	2	8	4
24.	Smuggling	-	-	3	-	-	-	-
25.	Abduction	2	2	13	-	-	2	-
26.	Other crimes	209	203	169	197	197	205	186

After the data is available, it will be processed so that it can be applied with the *exponential smoothing method*. The following data has been processed:

Table 2: Processed Data

No	Year	Amount	No	Year	Amount
1	2016	1	77	2019	62
2	2016	3	78	2020	62
3	2017	7	79	2021	35
4	2018	4	80	2022	41
5	2019	3	81	2016	42
6	2020	5	82	2017	28
7	2021	1	83	2018	32
8	2022	6	84	2019	27
9	2016	4	85	2020	27
10	2017	9	86	2021	35
11	2019	7	87	2022	28
12	2020	2	88	2016	210
13	2021	6	89	2017	142
14	2022	7	90	2018	151
15	2017	1	91	2019	170
16	2018	2	92	2020	170
17	2022	1	93	2021	142
18	2016	166	94	2022	132
19	2017	123	95	2016	6
20	2018	106	96	2017	6
21	2019	132	97	2018	10
22	2020	259	98	2019	6
23	2021	174	99	2020	6
24	2022	180	100	2021	9
25	2016	80	101	2022	6
26	2017	71	102	2016	87
27	2018	49	103	2017	102
28	2019	48	104	2018	101
29	2020	45	105	2019	102
30	2021	50	106	2020	102
31	2022	41	107	2021	115
32	2016	6	108	2022	126
33	2017	3	109	2016	117
34	2018	2	110	2017	74
35	2019	3	111	2018	105
36	2020	1	112	2019	132
37	2021	1	113	2020	132
38	2022	1	114	2021	101
39	2016	140	115	2022	124
40	2017	117	116	2016	45
41	2018	103	117	2017	37
42	2019	120	118	2018	30
43	2020	89	119	2019	27
44	2021	98	120	2020	27
45	2022	23	121	2021	26
46	2016	8	122	2022	30
47	2017	6	123	2016	2
48	2018	3	124	2017	1
49	2019	4	125	2019	1
50	2020	2	126	2020	1
51	2021	1	127	2021	1
52	2022	3	128	2016	2
53	2016	228	129	2017	1
54	2017	168	130	2018	6
55	2018	146	131	2019	6
56	2019	146	132	2020	6
57	2020	137	133	2021	4
58	2021	155	134	2022	5

59	2022	126	135	2016	5
60	2016	81	136	2017	2
61	2017	120	137	2019	2
62	2018	118	138	2020	2
63	2019	96	139	2021	8
64	2020	76	140	2022	4
65	2021	55	141	2018	3
66	2022	55	142	2016	2
67	2016	269	143	2017	2
68	2017	204	144	2018	13
69	2018	174	145	2021	2
70	2019	213	146	2016	209
71	2020	204	147	2017	203
72	2021	178	148	2018	169
73	2022	241	149	2019	197
74	2016	46	150	2020	197
75	2017	69	151	2021	205
76	2018	55	152	2022	186

The processed data will be applied using the *exponential smoothing* formula with the following formula:

$Ft = Ft\text{-}1 + \alpha\ (At\text{-}1 - Ft\text{-}1)$
information:
Ft = forecast value for the t-th period
At-1 = actual value of the period to t
Ft-1 = forecast value for past time period; t-1
α = konstanta pemulusan (*smoothing constant*)

To determine the value of the constant, the first thing to calculate is to determine the coefficient of α, with the formula α =(2/n+1), α = (2/152+1) = 1.01315 or rounded to 0.1, so the value of α = 0.1.

Step 2 is to calculate the forecasting value of the first period,
The way to calculate it is by adding up the total demand data then dividing by the number of existing periods, where the total of all requests is 10461 divided by the number of periods of 152 periods so, F (1) = 10461/152 = 68.82.

Step 3 is to calculate the forecasting value in the first period. Based on data from 152 periods, researchers tested the period of drug crime with periods 18-23. So F(18) = 166
F18 = 166 + 0.1 x (166 - 166) = 166
F19 = 166 + 0,1 x (123 – 166) = 156,13
F20 = 156,13 + 0,1 x (106 – 156,13) = 153,71
F21 = 153,71 + 0,1 x (132 – 153,71) = 164,24
F22 = 164,24 + 0,1 x (259 – 164,24) = 165,22
F23 = 165,22+ 0,1 x (174 – 165,22) = 166,69

So from the results of the first theft using *exponential smoothing*, it was found that the demand in 2023 was 166.69 narcotics crimes. So it produces a table like the following:

Table 3: Results of Narcotics Crime Forecasting

No	Year	Amount	Forecasting
1	2016	166	166
2	2017	123	166
3	2018	106	156,13
4	2019	132	153,71
5	2020	259	164,24
6	2021	174	165,22
7	2022	180	166,69

Next is the determination of Error, RSFE, Absolute Error, Cumulative Absolute Error, and MAD.
For error calculations, namely At-1 – Ft-1 as follows:
E18 = 166 – 166 = 0
E19 = 123 – 166 = -43
E20 = 106 – 156,13 = -50,13
E21 = 132 – 153,71 = -21,71
E22 = 259 – 164,24 = 94,76
E23 = 174 – 165,22 = 8,78
E23 = 180 – 166,69 = 13,31

For the calculation of RSFE, namely (S) = E as follows:
E18 = 0
E19 = 0 + (-43) = -43
E20 = (-43) + -50,13 = -93.13
E21 = -93.13 + (-21,71) = -114.84
E22 = -114.84 + 94,76 = -20.08
E23 = -20.08 + 8,78 = -11.3

For the calculation of Absolute Error = ABS E as follows:
E18 = 0
E19 = 43
E20 = 50.13
E21 = 21.71
E22 = 94.76
E23 = 8.78

For the calculation of Absolute Cumulative Error = Cumulative ABS E as follows:
E18 = 0
E19 = 0 + 43 = -43
E20 = 43 + 50,13 = 93.13
E21 = 93.13 + 21,71 = 114.84
E22 = 114.84 + 94,76 = 209,6
E23 = 209,6 + 8,78 = 218,38

For the calculation MAD = Cumulative ABS : Priode as follows:
E18 = 0
E19 = 0 / 43 = 21,5
E20 = 21,5 / 93.13 = 31,04
E21 = 31,04 / 114.84 = 28,71
E22 = 28,71 / 209,6 = 41,92
E23 = 41,92 / 218,38 = 36,39

Table 4 : Overall Results of Narcotics Crime Forecasting

No	Year	Actual Data	Forecasting	Error	RSFE	Absolut Error	Komulatif Absolut Error	MAD	Traking Signal
1	2016	166	166	0	0	0	0	0	0
2	2017	123	166	-43	-43	43	43	21.5	-2
3	2018	106	156.13	-50.13	-93.13	50.13	93.13	31.04333	-3
4	2019	132	153.71	-21.71	-114.84	21.71	114.84	28.71	-4
5	2020	259	164.24	94.76	-20.08	94.76	209.6	41.92	-0.47901
6	2021	174	165.22	8.78	-11.3	8.78	218.38	36.39667	-0.31047
7	2022	180	166.69	13.31					

4. Conclusions

From the results of the forecasting analysis that has been carried out by researchers, the conclusions that can be drawn in this study are as follows:

1. This study successfully implemented an exponential smoothing forecasting method to predict the increase in crime in the Binjai City Police. Using this approach, the system can generate forecasts based on historical data about previous crime rates.
2. The main advantage of this approach is its ability to capture trends and fluctuation patterns in crime data. By utilizing this method, the Binjai City Police can be better prepared for potential spikes in crime and allocate resources more effectively.
3. The website-based implementation allows easy and quick access to forecasting results for police officers, as well as other related parties. This allows them to take preventive measures and timely reactions.
4. However, it is important to remember that forecasting results are only predictions based on historical data, and unexpected factors can still influence the incidence of crime on the ground. Therefore, forecasting results need to be interpreted carefully and used as a guide, not a final decision.
5. Overall, this project makes a positive contribution in improving the readiness of the Binjai City Police in facing crime challenges with a data and technology-based approach.

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