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Prediction of Building Permit Approval in Medan City Using the Naïve Bayes Algorithm for Investment Prospects

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ABSTRACT
Property investment in Medan City has become increasingly important in line with economic growth and rapid infrastructure development. Over the past decade, property investment in Medan has shown significant growth, as evidenced by the expansion of residential areas, boarding houses, hotels, and integrated apartments such as Manhattan Square, Jati Junction, and Podomoro Deli Park. This study aims to predict and identify patterns of Building Permit Approval (PBG) in Medan City that are significantly related to investment prospects. The algorithm used in this study is Naïve Bayes, implemented using the Orange tool, which enables the prediction of building permit approvals in Medan City. The key findings of this study indicate the existence of significant building permit approval patterns and the identification of potential investment areas. The implications of this research are crucial for investors and developers in formulating more effective investment strategies.

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INTRODUCTION

Medan City, as the capital of North Sumatra Province, has experienced significant economic growth in recent years. It is considered one of Indonesia's most attractive property investment destinations [1]. Several factors contribute to this appeal, including its strategic location near Thailand, Malaysia, and Singapore, along with relatively well-developed infrastructure. These conditions make Medan an attractive hub for export-import trade. The presence of Kualanamu International Airport and Belawan International Container Port further supports this growth. According to the Central Statistics Agency (BPS) of North Sumatra, Medan City's economic growth reached 5.04% in 2023, indicating promising investment potential (BPS, 2024)[2]. The property investment sector offers lucrative returns, with an average annual property price increase of approximately 20% in Indonesia (Mokoginta). Additionally, property investment serves as a reliable source of passive income with consistent growth over time.

The property investment potential in Medan is expected to be concentrated in the vertical housing sub-sector. Changes in lifestyle, traffic congestion, and high mobility have increased people's interest in living in apartments [3]. Time efficiency and accessibility to various services are key considerations compared to landed housing on the outskirts of Medan, despite its lower cost. The areas with potential for the growth of apartments, malls, and office buildings include Medan Belawan District, Medan Labuhan District, Medan Deli District, Medan Amplas District, and the city center. According to Medan City's Medium-Term

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Development Plan (RPJM), these areas are designated as strategic zones for economic growth. Meanwhile, residential property, including landed houses and boarding houses, is projected to thrive in the northern and southern areas, such as Medan Deli, Medan Marelan, and Medan Belawan in the north, as well as Medan Baru, Medan Selayang, and Medan Tuntungan in the south. The rapid urban development in Medan necessitates an efficient and effective permitting system, one of which is the Building Permit Approval (PBG). PBG is a permit granted to building owners for new construction, modification, expansion, reduction, and/or maintenance of buildings in compliance with technical building standards [4]. However, the approval process often involves lengthy procedures and complex requirements. Therefore, a system is needed to predict the likelihood of PBG approval quickly and accurately.

However, despite this potential, investors and developers face several challenges, particularly related to the lack of information regarding building permit approval patterns and their impact on investment prospects. Therefore, this study aims to predict building permit approvals in Medan City. The Naïve Bayes algorithm is one of the machine learning algorithms that can be used for prediction and classification [5]. This algorithm is relatively simple, easy to implement, and performs well across various types of data. This study aims to implement the Naïve Bayes algorithm to predict and identify patterns of Building Permit Approval (PBG) in Medan City for investment prospects. The proposed hypothesis is that there are distinct building permit approval patterns based on location and building function that can influence investment decisions.This study is expected to contribute to investors, developers, local governments, and academics in understanding the dynamics of property investment in Medan City.

METHODS

This study is conducted through the following steps:

1. Collecting Building Permit Approval (PBG) data from secondary sources provided by the Investment and One-Stop Integrated Service Agency (DPMPTSP) of Medan City from 2018 to 2023. Secondary data refers to data that has been previously collected by other individuals or institutions and can be accessed by researchers for specific research purposes [6].
2. Gathering relevant journal articles on the application of the Naïve Bayes algorithm for predicting Building Construction Permits, which are now referred to as Building Permit Approvals (PBG) [7], [8], [9], [10], [11], [12][13].
3. Performing data preprocessing, including selecting operational data, cleaning duplicate entries, checking for inconsistencies, and correcting errors such as typographical mistakes. This step also involves data enrichment, a process in which existing data is updated or supplemented with additional information from other sources to improve data quality and value [14], [15].
4. Developing and analyzing the model using the Naïve Bayes algorithm with the Orange tool. Orange is an open-source software platform used for data analysis, machine learning, and data visualization [16].

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RESULTS AND DISCUSSION

Data Collection

NO	NOMOR IJIN	TANGGAL TERBIT	SKRD (Rp)	TGL MASUK	LOKASI BANGUNAN	KECAMATAN LOKASI	KELURAHAN LOKASI	FUNGSI BANGUNAN
1	0001/0015/0015/2.5/2108/12/2017	02/01/2018	106.198.400,00	30/10/2017	Jl. Bunga Rinte	Kecamatan Medan Tuntungan	Kel. Tanjung Selamat	Toko, Kantor dan Rumah Tempat Tinggal sert
2	0002/0001/0017/2.5//12/2017	04/01/2018	2.872.031,00	30/10/2017	Jl. Pelajar Timur No. 219 A	Kecamatan Medan Denai	Kelurahan Binjai	Rumah Tempat Tinggal dan Pagar
3	0003/0002/0008/2.5/0405/12/2017	08/01/2018	2.323.750,00	27/10/2017	Jl. Taska No. 113	Kecamatan Medan Deli	Kel. Titi Papan	Rumah Tempat Tinggal dan Pagar
4	0004/0003/0059/2.5/1309/01/2018	09/01/2018	13.171.125,00	31/10/2017	Jl. Martapura No. 24	Kecamatan Medan Kota	Kel. Pasar Baru	Toko
5	0005/0004/0072/2.5/1706/01/2018	09/01/2018	4.939.688,00	31/10/2017	Jl. Selamat Sudut Gang Sederhana	Kecamatan Medan Denai	Kel. Binjai	Rumah Tempat Tinggal dan Pagar
6	0006/0005/0040/2.5/2107/12/2017	09/01/2018	1.433.025,00	31/10/2017	Jl. Bunga Rinte Gang Bunga Mawar I	Kecamatan Medan Tuntungan	Kel. Simpang Selayang	Rumah Tempat Tinggal dan Pagar
7	0007/0006/0025/2.5/1005/12/2017	11/01/2018	30.137.800,00	31/10/2017	Jl. Gaperta No. 232/ Jl. Beringin XI	Kecamatan Medan Helvetia	Kel. Helvetia	Toko
8	0008/0007/0073/2.5/1703/01/2018	16/01/2018	1.830.125,00	13/11/2017	Jl. Rawa Gang Karya No. 19	Kecamatan Medan Denai	Kel. Tegal Sari Mandala III	Rumah Tempat Tinggal dan Pagar
9	0009/0011/0089/2.5/1606/01/2018	16/01/2018	43.468.425,00	13/11/2017	Jl. Letjen Suprapto/ Gang	Kecamatan Medan Maimun	Kel. Aur	Toko
10	0010/0012/0103/2.5/1002/01/2018	16/01/2018	1.844.906,00	14/11/2017	Jl. Makmur Lk. V	Kecamatan Medan Helvetia	Kel. Cinta Damai	Rumah Tempat Tinggal dan Pagar
11	0011/0013/0139/2.5/2004/01/2018	16/01/2018	2.358.125,00	22/11/2017	Jl. Sei Padang Sudut Jalan Komplek	Kecamatan Medan Selayang	Kel. Padang Bulan Selayang I	Rumah Tempat Tinggal dan Pagar
12	0012/0010/0132/2.5/1905/01/2018	16/01/2018	1.328.250,00	21/11/2017	Jl. Kiwi	Kecamatan Medan Sunggal	Kel. Sei Sikambing B	Rumah Tempat Tinggal dan Pagar
13	0013/0009/0038/2.5/0912/01/2018	16/01/2018	1.377.063,00	14/11/2017	Jl. Biawak No. 71	Kecamatan Medan Area	Kel Pandau Hulu II	Rumah Tempat Tinggal dan Pagar
14	0014/0008/0102/2.5/0503/01/2018	16/01/2018	5.426.850,00	14/11/2017	Jl. Bambu I/ Jl. Sehati	Kecamatan Medan Timur	Kel. Durian	Rumah Tempat Tinggal dan Pagar
15	0015/0014/0060/2.5/1706/01/2018	18/01/2018	2.092.063,00	13/11/2017	Jl. Raya Medan Tenggara No. 291	Kecamatan Medan Denai	Kel. Binjai	Rumah Tempat Tinggal dan Pagar
16	0016/0015/0093/2.5/0301/01/2018	18/01/2018	1.735.938,00	13/11/2017	Jl. Jala Raya	Kecamatan Medan Labuhan	Kel. Besar (Kampung Besar)	Rumah Tempat Tinggal dan Pagar
17	0017/0016/0077/2.5/1001/01/2018	18/01/2018	2.239.875,00	24/11/2017	Jl. Bakti Indah IV	Kecamatan Medan Helvetia	Kel. Tanjung Gusta	Rumah Tempat Tinggal dan Pagar
18	0018/0017/0166/2.5/1007/01/2018	18/01/2018	3.210.213,00	24/11/2017	Jl. Komplek Pondok Surya Blok VI No. 232	Kecamatan Medan Helvetia	Kel. Helvetia Timur	Rumah Tempat Tinggal dan Pagar
19	0020/0018/0109/2.5/0805/01/2018	19/01/2018	30.284.100,00	15/11/2017	Jl. Flores No. 10/ Gang	Kecamatan Medan Perjuangan	Kel. Pandau Hilir	Toko
20	0021/0021/0034/2.5/1404/01/2018	19/01/2018	9.201.156,00	24/11/2017	Jl. Karya Utama	Kecamatan Medan Johor	Kel. Pangkalan Masyhur	Rumah Tempat Tinggal dan Pagar
21	0022/0019/0070/2.5/0807/01/2018	19/01/2018	4.074.469,00	24/11/2017	Jl. Pelita II	Kecamatan Medan Perjuangan	Kel. Sidorame Barat I	Rumah Tempat Tinggal dan Pagar
22	0023/0020/0078/2.5/1103/01/2018	19/01/2018	33.763.950,00	24/11/2017	Jl. H. Adam Malik No. 47 Sudut Gang Selamat	Kecamatan Medan Petisah	Kel. Sekip	Toko
23	0024/0022/0169/2.5/0203/01/2018	22/01/2018	24.147.750,00	24/11/2017	Jl. Rahmad Budin	Kecamatan Medan Marelan	Kel. Terjun	Tower dan Pagar
24	0025/0023/0118/2.5/0606/01/2018	22/01/2018	3.188.488,00	17/11/2017	Jl. Deli Indah V Sudut Jalan Deli Indah VIII	Kecamatan Medan Barat	Kel. Pulo Brayan Kota	Rumah Tempat Tinggal dan Pagar
25	0026/0024/0239/2.5/2004/01/2018	22/01/2018	2.896.025,00	15/12/2017	Jl. DR. Mansyur sudut Jl. SMTK	Kecamatan Medan Selayang	Kel. Padang Bulan Selayang I	Rumah Tempat Tinggal dan Pagar
26	0027/0025/0101/2.5/0606/01/2018	23/01/2018	1.436.875,00	14/11/2017	Jl. Deli Indah IX No. 16-E	Kecamatan Medan Barat	Kel. Pulo Brayan Kota	Rumah Tempat Tinggal dan Pagar

PBG07022025

Figure 1. Process Data Collection

Pre-Processing

Data: **Jurnal2 Naive Bayes rev-DATAPBG07022025 TES**: 6456 instances, 6 variables
Features: 4 (2 categorical, 2 numeric) (0.1% missing values)
Target: categorical
Metas: string

	PROSPEK	JENIS BANGUNAN	LOKASI	JNGSI BANGUNA	SKRD (RP)	TAHUN TERBIT
1	Komersial	Toko, Kantor da...	Medan ...	Campuran	106198400	2018
2	Non Komersial	Rumah Tempat ...	Medan Denai	Hunian	2872031	2018
3	Non Komersial	Rumah Tempat ...	Medan Deli	Hunian	2323750	2018
4	Komersial	Toko	Medan Kota	Usaha	13171125	2018
5	Non Komersial	Rumah Tempat ...	Medan Denai	Hunian	4939688	2018
6	Non Komersial	Rumah Tempat ...	Medan ...	Hunian	1433025	2018
7	Komersial	Toko	Medan Helvetia	Usaha	30137800	2018
8	Non Komersial	Rumah Tempat ...	Medan Denai	Hunian	1830125	2018
9	Komersial	Toko	Medan Maimun	Usaha	43468425	2018
10	Non Komersial	Rumah Tempat ...	Medan Helvetia	Hunian	1844906	2018

Data Subset: -

Figure 2. Data Pre-Processing

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Modeling and Analysis

Predictions: Jurnal2 Naive Bayes rev-DATAPBG07022025 TES: 6456 instances, 10 variables
Features: 4 (2 categorical, 2 numeric) (0.1% missing values)
Target: categorical
Metas: 5 (2 categorical, 2 numeric, 1 string)

	PROSPEK	JENIS BANGUNAN	Naive Bayes	ive Bayes (Komers	ayes (Non Ko	Fold	LOKASI	I BANG	SKRD (RP)	TAHUN
1	Non Komersial	Rumah Tempat ...	Non ...	0.000223941	0.999776	1	Meda...	Hunian	2323750	2018
2	Komersial	Toko	Komersial	0.994335	0.00566479	1	Meda...	Usaha	43468425	2018
3	Non Komersial	Rumah Tempat ...	Non ...	0.000160574	0.999839	1	Meda...	Hunian	1377063	2018
4	Non Komersial	Rumah Tempat ...	Non ...	0.000255193	0.999745	1	Meda...	Hunian	5426850	2018
5	Non Komersial	Rumah Tempat ...	Non ...	6.40454e-05	0.999936	1	Meda...	Hunian	2092063	2018
6	Komersial	Toko	Komersial	0.99168	0.00832041	1	Meda...	Usaha	30284100	2018
7	Non Komersial	Rumah Tempat ...	Non ...	6.78871e-05	0.999932	1	Meda...	Hunian	1974500	2018
8	Komersial	Toko	Komersial	0.994585	0.00541518	1	Meda...	Usaha	26365763	2018
9	Komersial	Toko	Komersial	0.994585	0.00541518	1	Meda...	Usaha	15806175	2018

Evaluation Results: 1 method on 6456 test instances

Figure 3. Data Modeling

In Figure 3, the Naïve Bayes algorithm model presents a predictive analysis of Building Permit Approval (PBG) data in Medan City, which includes building function, building type, building location, year of issuance, and SKRD. These factors are significantly related to investment prospects, categorized as Commercial and Non-Commercial [17].

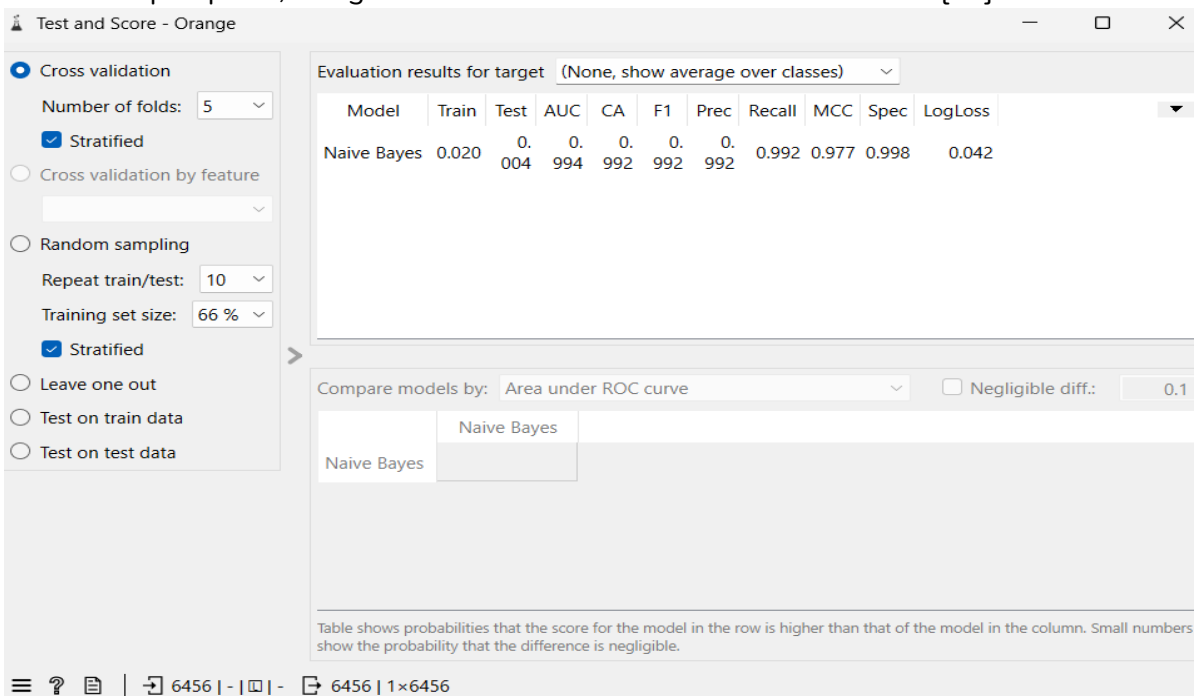

Figure 4. Test dan Score

Journal Of Data Science
Volume 3, Number 01, 2025, DOI 10.58471/Science.v3i01
ESSN 3025-2792 (Online)
https://ejournal.seaninstitute.or.id/index.php/visualization

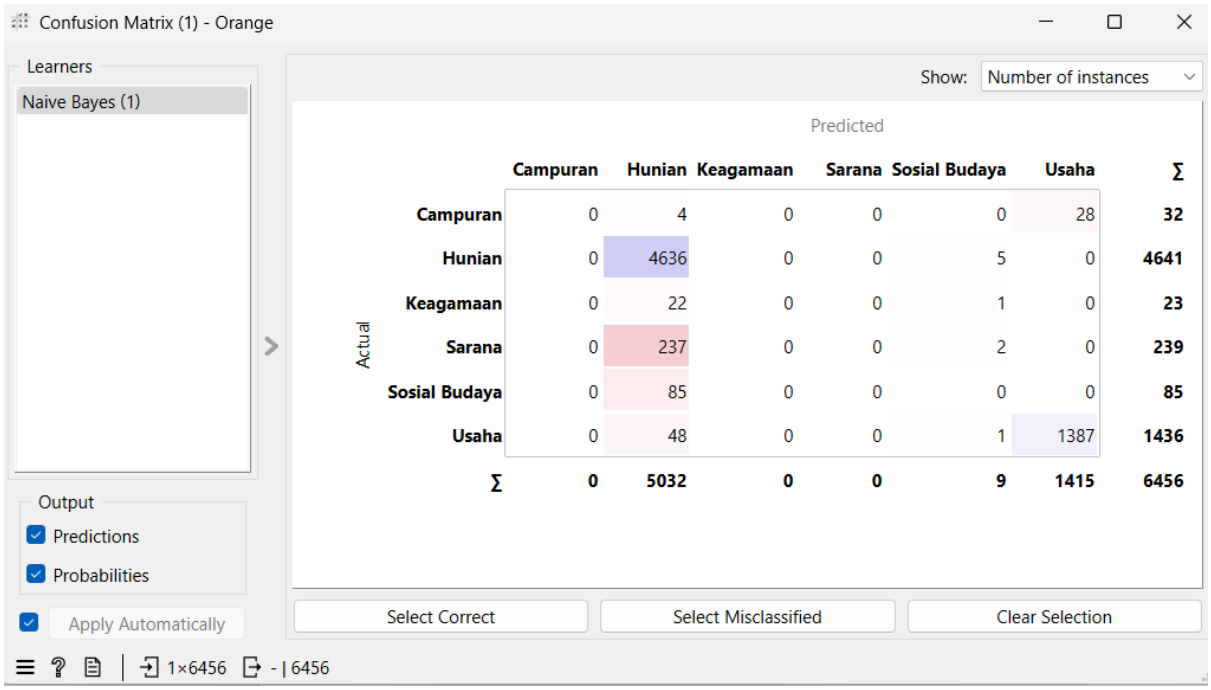

Figure 5. Confusion Matrik 1

In Figure 6, Confusion Matrix 1 illustrates the prediction of Building Permit Approval (PBG) in Medan City. It shows that PBG for residential building functions has the highest rating, with a total of 5,032 approvals. Meanwhile, business building functions account for 1,415 approvals, and mixed-use, religious, and facility-related building functions have a total of 0 approvals.

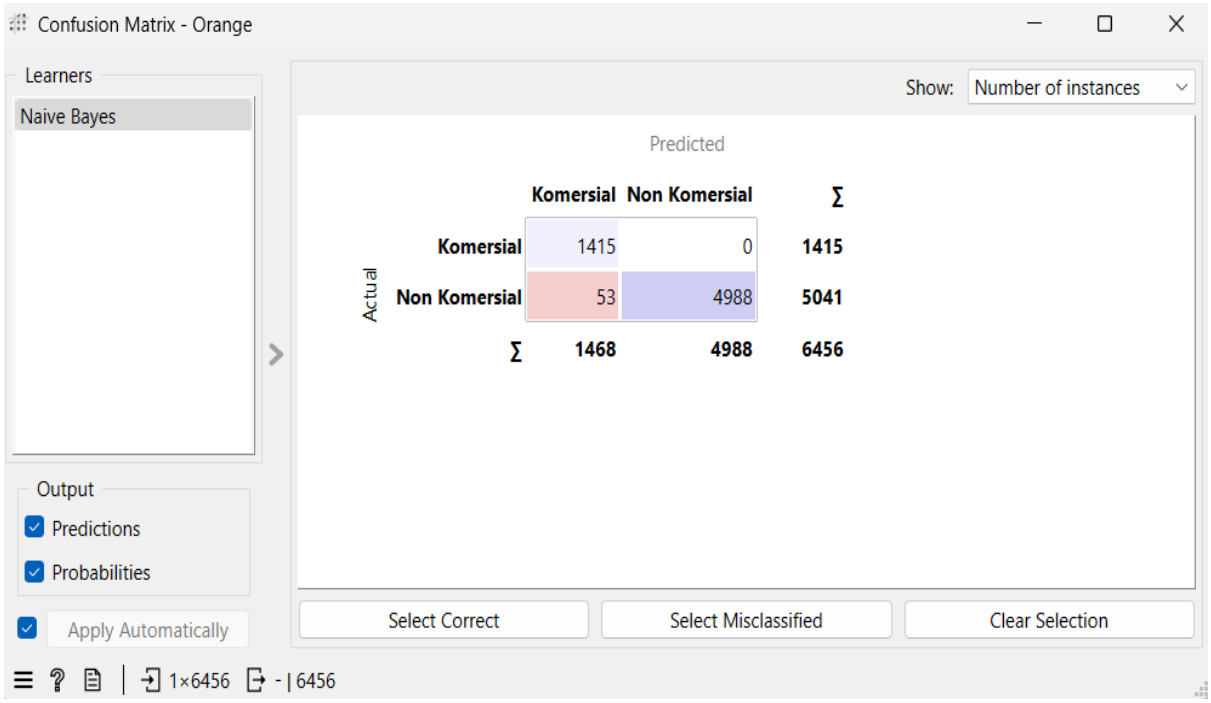

Figure 6. Confusion Matrik 2

Journal Of Data Science
Volume 3, Number 01, 2025, DOI 10.58471/Science.v3i01
ESSN 3025-2792 (Online)
https://ejournal.seaninstitute.or.id/index.php/visualization

In Figure 7, Confusion Matrix 2 shows that the prediction for Building Permit Approval (PBG) related to commercial investment is 1,468 approvals, while non-commercial investment accounts for 4,988 approvals.

CONCLUSION

The analysis and evaluation of the modeling results indicate that the Naïve Bayes algorithm demonstrates strong performance in predicting Building Approval (PBG) data at the Investment and One-Stop Integrated Services Office (DPMPTSP) of Medan City. The Naïve Bayes model achieves high evaluation metrics, with an F1-Score of 0.992, Precision of 0.992, and Recall of 0.992, highlighting its effectiveness in accurately predicting classes, minimizing prediction errors, and correctly identifying most actual positive cases. For future research, it is recommended to use a larger and more diverse dataset to enhance model performance and generalization; incorporate additional features by exploring other relevant variables for predicting building approvals; experiment with different algorithms and tools to further improve accuracy; and deploy the predictive model as an investment information tool for Medan City, accessible through a user-friendly application, such as a web or mobile app, to benefit property developers and investors.

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