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Automatic Purchase Order Classification Using SVM in POS System at Skus Mart

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Abstract: In retail business processes, decision-making regarding Purchase Order (PO) submissions often remains manual and subjective, creating risks that impede procurement efficiency. The study develops an automatic classification model to predict PO approval status using Support Vector Machine (SVM) algorithm integrated within Point of Sale (POS) systems. Historical purchase transaction data was obtained from SKUS Mart's POS database containing 133 entries, including attributes such as item quantity, purchase price, previous stock levels, and total purchase amounts. The research applies CRISP-DM methodology, encompassing business understanding, data exploration, preprocessing (normalization using StandardScaler), model training, evaluation, and deployment phases. The model was trained using linear kernel and validated through holdout technique with 80:20 ratio for training and testing. Test results demonstrate that the SVM model achieves 76.69% accuracy, 82.21% precision, 76.69% recall, and 78.51% F1-score. The model was implemented in a web-based POS system (CodeIgniter 3) combined with Python scripts to generate automatic classifications displayed directly in the user interface. Although the model demonstrates adequate performance, the study has not compared its effectiveness against other machine learning algorithms such as Random Forest or K-Nearest Neighbor. These findings establish initial groundwork for machine learning integration to support decision automation in procurement systems.

Keywords: Support Vector Machine; Purchase Order; Point of Sale; Automatic Classification; CRISP-DM.

1. Introduction

The rapid advancement of information technology has fundamentally transformed business landscapes, driving massive digital transformation across various industry sectors. The trade and retail sector, as one of the primary economic pillars, has experienced significant evolution in managing business operations. According to Statistics Indonesia (BPS) data, the wholesale and retail trade sector contributed approximately 13.3% to Indonesia's Gross Domestic Product (GDP) in 2023, making it one of the strategic sectors in the national economy. The substantial role of the sector demands high operational efficiency to maintain competitiveness in the digital era.

Point of Sale (POS) systems have become the operational heart of modern retail activities. No longer merely functioning as transaction recorders, POS systems have evolved into integrated platforms encompassing inventory management, real-time sales tracking, consumer behavior analysis, and goods procurement processes. Arman and Maberur (2022) demonstrated in their research that proper POS system implementation can significantly enhance store operational efficiency [1]. Similarly, Hanggaraxsha and Gunawan (2024) developed a web-based POS application integrated with WhatsApp, proving that POS system innovation can add value in customer communication [2]. The development of web-based POS systems has gained increasing attention due to their flexibility and accessibility. Isfahani *et al*. (2022) implemented a web-based POS information system for Point Coffee Banjarmasin, demonstrating the effectiveness of web platforms in managing transactions and inventory [3]. Nistrina and Rahmania (2021) also developed a website-based POS system for PT Barokah Kreasi Solusindo, proving that web-based solutions can be adapted for various business types [4]. Furthermore, Gani *et al*. (2023) implemented a web-based POS system at Dapur Caringin Tilu Bandung, emphasizing the importance of system integration to improve operational efficiency [5].

POS system development methodology has also experienced rapid advancement. Siddik and Samsir (2020) applied object-oriented programming concepts in building POS systems, providing more organized and maintainable code structures [6]. Nugraha (2021) utilized the waterfall method in developing web-based POS systems, proving the effectiveness of systematic approaches in software development [7]. Herdiansyah *et al*. (2021) also applied the waterfall method in designing POS systems for Toko Azam Grosir, demonstrating methodological approach consistency in developing similar systems [8].

In operational activities, goods procurement processes through Purchase Order (PO) mechanisms play crucial roles in maintaining supply chain flow and stock availability. Effective procurement processes not only ensure operational continuity but also optimize cash flow and minimize dead stock risks. However, field reality shows that PO approval processes in many small and medium enterprises still rely on manual and subjective approaches. Management often makes decisions based on intuition or personal experience, without objective data analysis support. Manual approaches in PO approval create various operational problems. Delays in approval processes can cause stockouts that impact lost sales opportunities and customer satisfaction. Conversely, overly lenient approvals can cause overstocking that ties up working capital and increases storage costs. Inconsistency in approval criteria can also create bias in decision-making, ultimately affecting operational efficiency and company profitability.

The digital era demands more objective and data-driven approaches in business decision-making. Machine learning has emerged as a promising solution for automating complex decision-making processes. In classification scenarios, Support Vector Machine (SVM) algorithms have proven superior performance, especially for binary classification problems. SVM has the ability to work effectively on high-dimensional data and is relatively robust against overfitting, particularly on medium-sized datasets. SVM applications across various domains have shown promising results. Tundo *et al*. (2024) applied SVM for sentiment analysis of cigarette use based on opinions from platform X, demonstrating SVM effectiveness in classifying text sentiment [9]. Akbar *et al*. (2024) implemented the Naive Bayes method in Looker Studio, which despite using different algorithms, showed the importance of machine learning approaches in educational data analysis [10].

Silviana *et al*. (2024) applied SVM algorithms to tourist visitor reviews in Kuningan Regency, proving SVM capability in classifying tourism review sentiment [11]. In the financial domain, Yanti and Asana (2023) developed a credit application classification system using SVM methods, demonstrating SVM potential in supporting financial decision-making [12]. Chairunnisa *et al*. (2022) used SVM with Chi-Square feature selection to classify sentiment in PeduliLindungi application reviews, proving the effectiveness of combining SVM with feature selection techniques [13]. Triwati *et al*. (2025) implemented SVM for student tuition fee classification, showing SVM adaptability in various application scenarios [14].

Although SVM applications have proven effective across various domains, its specific application in POS systems for PO approval status classification remains underexplored. Most previous research focused on SVM applications in sentiment analysis, text classification, or financial prediction, but few have examined its potential in automating goods procurement processes. Additionally, direct integration of machine learning algorithms into web-based POS application workflows is still rarely found in literature. Another research gap lies in the lack of detailed explanations regarding practical implementation of machine learning models in real

operational systems. Many studies only focus on algorithmic aspects without discussing how such models are integrated, used, and maintained in production environments. The gap creates a disconnect between academic research and practical applications in the industrial world.

Based on the identified problems and research gaps, the study aims to develop an automatic classification model using Support Vector Machine (SVM) algorithm to predict Purchase Order (PO) approval status based on historical purchase transaction data. The developed model will be implemented in a web-based POS system using Python integration and CodeIgniter 3 framework, enabling direct use in business operations. The research is expected to provide practical solutions for automating PO approval processes, reducing subjective bias in decision-making, and improving operational efficiency in goods procurement. With objective and data-driven approaches, companies can make goods procurement decisions more quickly, accurately, and consistently, ultimately enhancing business competitiveness and profitability.

2. Related Work

The application of machine learning algorithms, particularly Support Vector Machine (SVM), has gained significant attention across various domains for classification tasks. The following section reviews relevant studies that demonstrate the effectiveness and versatility of SVM in different application areas, providing a foundation for understanding its potential in Purchase Order approval classification.

2.1 SVM Applications in Business and Inventory Management

The implementation of SVM in business decision-making processes has shown promising results across different sectors. Pratama *et al*. (2020) implemented SVM classification methods to determine stock inventory at Koperasi Karyawan Pangan Utama, demonstrating the algorithm's capability in inventory management decisions [16]. Their study achieved satisfactory accuracy in predicting stock requirements, which directly relates to procurement decision-making processes similar to PO approval systems. Building upon inventory management applications, the integration of machine learning in Point of Sale systems has evolved significantly. Previous research by Arman and Maberur (2022) showed that proper POS system implementation can enhance operational efficiency [1], while Hanggaraxsha and Gunawan (2024) demonstrated the value of integrating modern technologies like WhatsApp into POS applications [2]. These studies establish the foundation for incorporating advanced algorithms like SVM into POS environments.

2.2 Comparative Algorithm Performance Studies

Several studies have conducted comparative analyses to evaluate SVM performance against other machine learning algorithms. Pramansah *et al*. (2022) performed a comparative analysis between SVM and K-Nearest Neighbor (KNN) algorithms for anime genre classification, revealing SVM's classification capabilities in categorical data [17]. Their findings indicated that SVM maintained consistent performance across different data distributions, which proves crucial for business applications where data patterns may vary. Aprihartha *et al*. (2025) conducted a comparison of Real Adaptive Boosting algorithms on Logistic Regression, CART, and Naive Bayes for pumpkin seed classification [15]. Although their study focused on agricultural applications, the comparative methodology offers valuable insights for evaluating SVM performance in business classification tasks. The study emphasized the importance of algorithm selection based on data characteristics and problem requirements.

2.3 SVM in Healthcare and Medical Classification

The healthcare sector has extensively utilized SVM for various classification tasks, demonstrating the algorithm's robustness across different domains. Septhya *et al*. (2023) implemented Decision Tree and SVM algorithms for lung cancer disease classification, achieving notable accuracy in medical diagnosis [19]. Their study revealed SVM's ability to handle complex medical data with multiple features, which parallels the multi-attribute nature of business transaction data. Sabatini and Itan (2024) implemented SVM for Monkeypox case classification using oversampling and undersampling approaches to address class imbalance [20]. Their research proves particularly relevant as it addresses data imbalance issues commonly encountered in business datasets, where approved and rejected POs may not be equally distributed. Lumbanraja *et al*. (2022) applied SVM for diabetes mellitus patient classification, showcasing the algorithm's effectiveness in binary classification problems [22]. Their methodology and evaluation metrics provide a template for implementing SVM in binary classification scenarios, which directly applies to PO approval status prediction.

2.4 Educational and Social Applications of SVM

Educational institutions have successfully implemented SVM for various classification tasks. Nugraha (2021) utilized SVM algorithms for classifying tuition fee adjustments for students affected by the COVID-19

pandemic at Universitas Siliwangi [21]. The study demonstrated SVM's capability in handling financial classification problems within educational institutions, which shares similarities with business financial decision-making processes. Mulyana and Lutfianti (2023) applied sentiment analysis using SVM algorithms to analyze netizen responses regarding 2023 recession news [18]. Their work demonstrated SVM's effectiveness in processing textual data and extracting meaningful patterns, which could prove valuable for analyzing textual descriptions or comments in PO systems. Similarly, Safitri and Fitrani (2022) implemented SVM with Gaussian RBF kernel for predicting election participation based on Surabaya city demographics [23], demonstrating SVM's capability in handling demographic data and making predictions based on population characteristics.

2.5 Advanced SVM Implementations and Web Integration

Recent studies have explored advanced SVM implementations across various domains. Jalil *et al*. (2024) implemented SVM algorithms for stunting status classification in toddlers, demonstrating the algorithm's effectiveness in health-related binary classification tasks [25]. Abimanyu *et al*. (2023) implemented SVM and t-Distributed Stochastic Neighbor Embedding (t-SNE) methods for depression classification, showcasing the integration of SVM with dimensionality reduction techniques [24]. In industrial applications, Arisona *et al*. (2025) developed a classification system based on SVM for determining operational targets in electricity usage control with conventional meters, focusing on industrial and business tariff customers from PT PLN Indonesia [26]. Gonzalez-Lima *et al*. (2024) proposed a graph classification method based on SVM and Locality-Sensitive Hashing, showcasing advanced SVM implementations for complex data structures [27]. The integration of machine learning algorithms into web-based systems has been demonstrated in various POS implementations. Isfahani *et al*. (2022) developed web-based POS systems for Point Coffee Banjarmasin [3], while Nistrina and Rahmania (2021) created website-based POS systems for PT Barokah Kreasi Solusindo [4]. Gani *et al*. (2023) implemented web-based POS systems at Dapur Caringin Tilu Bandung, emphasizing system integration importance [5]. These studies, combined with methodological approaches demonstrated by Siddik and Samsir (2020) using object-oriented programming concepts [6], provide a foundation for implementing SVM algorithms within existing POS architectures.

2.6 Research Positioning and Gap Analysis

While the reviewed studies demonstrate SVM's effectiveness across various domains, several gaps remain in the literature. Most SVM applications focus on healthcare, sentiment analysis, or general classification tasks, with minimal research specifically addressing procurement decision-making in retail environments. Additionally, few studies have demonstrated the practical integration of SVM algorithms into operational POS systems for real-time business decision support. The current research addresses these gaps by specifically focusing on PO approval classification within POS systems, providing a practical implementation that bridges academic research with business operational needs. The study builds upon the established effectiveness of SVM in various classification tasks while addressing the specific requirements of retail procurement decision-making processes.

3. Research Method

This research employs the CRISP-DM (Cross Industry Standard Process for Data Mining) approach as the primary methodology. CRISP-DM consists of six stages: Business Understanding, Data Understanding, Data Preparation, Modeling, Evaluation, and Deployment. The methodology was selected due to its iterative and flexible nature in developing data-driven solutions, as demonstrated in various machine learning studies [16].

3.1 Business Understanding

The main problem in the POS system at SKUS Mart involves the manual approval process for Purchase Orders (PO) conducted by management. The process consumes considerable time and potentially introduces bias. The research aims to build an automatic classification system based on machine learning to assist management in making more objective and efficient decisions. Similar approaches have been successfully implemented in other business classification systems to improve operational efficiency [26].

3.2 Data Understanding

Data was obtained from the POS system database (MySQL) at SKUS Mart, specifically from two main tables: trx_pembelianheader storing primary PO information including nofaktur, kode suplier, and status_approve, and trx_pembeliandetail containing item details such as kode barang, jumlah, harga_beli, stok_lama, and total. The dataset comprises 133 entries collected from January to December 2023. The target label is status_approve with two classes: 1 (Approve) and 2 (Reject). The dataset size aligns with similar research using medium-sized datasets for SVM classification [22].

3.3 Data Preparation

Data preparation began with joining the header and detail tables using JOIN operations to create a complete dataset. Four numerical features were selected: jumlah, harga_beli, stok_lama, and total, considered most relevant for PO approval prediction. Data cleaning involved removing empty records and rows with invalid labels to ensure dataset quality. Normalization using StandardScaler was applied to standardize numerical features for consistent scaling. Data splitting employed train_test_split with an 80% training and 20% testing ratio following standard machine learning practices. The preprocessing techniques follow best practices applied in SVM classification research for handling data imbalance [20].

3.4 Modeling

The algorithm employed was Support Vector Machine (SVM) from the scikit-learn library using a linear kernel. Linear kernel selection was based on several considerations: the relatively small dataset size (n = 133) makes non-linear kernels like RBF prone to overfitting, the binary classification nature suits SVM linear characteristics, and linear kernel computation is lighter and more efficient. Model parameters included kernel = 'linear' for linear classification, class_weight = 'balanced' to handle class imbalance, and random_state = 42 for result reproducibility. The model was trained using training data and saved as svm_model.pkl using pickle for deployment. Linear kernel selection aligns with research demonstrating linear kernel effectiveness for medium-sized datasets [23].

3.5 Evaluation

Model evaluation was conducted using testing data with various evaluation metrics: accuracy to measure correct prediction percentage, precision to assess positive prediction accuracy, recall to measure the model's ability to detect positive classes, F1-Score as the harmonic mean of precision and recall, and confusion matrix for detailed classification error analysis. The validation technique employed was Holdout Validation with 80:20 data splitting. These evaluation metrics follow standards used in similar SVM classification research (Jalil *et al.*, 2024) [25], enabling result comparison with previous studies.

3.6 Deployment

The trained model was integrated into the CodeIgniter 3-based POS system through a hybrid approach between Python and PHP. Integration was achieved by executing Python scripts (script.py) from PHP controllers using shell_exec() function for external script execution. The model processes new PO data based on nofaktur as the primary input and generates status predictions as Approve or Reject in JSON format. Prediction results are then displayed in the system interface to assist management decision-making. The integration approach adapts methodologies successfully implemented in web-based POS systems (Gani *et al.*, 2023) and CodeIgniter-based application development with machine learning integration [5][7].

4. Result and Discussion

4.1 Results

4.1.1 Model Evaluation Results

Following the training process using Support Vector Machine (SVM) algorithm with linear kernel, evaluation was conducted on test data comprising 20% of the total dataset, specifically 27 test samples from the complete 133 data points. The evaluation process generated several performance metrics that demonstrate the model's capability in classifying Purchase Order approval status. The SVM model achieved an accuracy of 76.69%, precision of 82.21%, recall of 76.69%, and F1-Score of 78.51%. These evaluation results indicate that the model possesses adequate classification ability for the limited dataset size, with relatively high precision signaling that positive predictions generated by the model tend to be accurate.

Table 1. SVM Model Evaluation Results

Evaluation Metric	Value
Accuracy	76.69%
Precision	82.21%
Recall	76.69%
F1-Score	78.51%

4.1.2 Confusion Matrix Analysis

To analyze the distribution of model predictions across each class (Approve and Reject), the confusion matrix provides detailed insights into classification performance. From 108 data points labeled as Approve, 85 were correctly predicted, while 23 were misclassified as Reject (false negatives). Meanwhile, from 25 data

points labeled as Reject, 17 were correctly predicted, and 8 were misclassified as Approve (false positives). Although the model shows a tendency to overpredict the Approve class, overall performance remains stable for the limited dataset size.

Table 2. SVM Model Confusion Matrix

	Predicted Approve	Predicted Reject
Actual Approve	85	23
Actual Reject	8	17

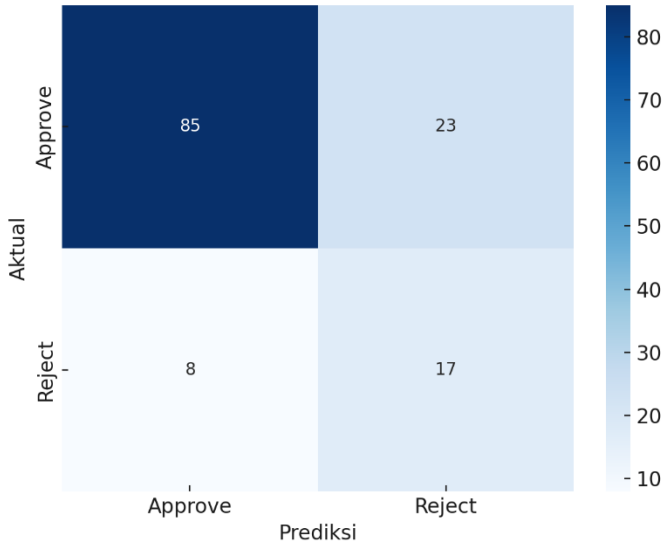

Figure 1. SVM Model Confusion Matrix

4.1.3 Model Integration into POS System

The trained model was subsequently integrated into the web-based POS system using CodeIgniter 3 framework through a hybrid approach that combines Python's machine learning capabilities with PHP's web development flexibility. Integration was accomplished through Python script (script.py) invocation from PHP controllers using shell_exec() command, which enables external script execution. When users access the Purchase Order (PO) detail page, the system automatically retrieves PO data based on invoice number, executes Python script to load the SVM model and process predictions, returns classification results in JSON format, and displays prediction status on the user interface page. Such integration approaches have proven effective in various web-based POS system implementations [5].

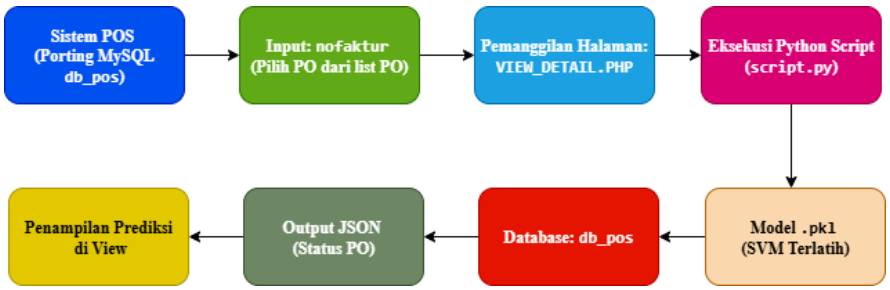

Figure 2. System Integration Diagram.

4.2 Discussion

Evaluation results demonstrate that the SVM model can classify PO approval status with adequate performance for practical business applications. The high precision value (82.21%) indicates that most Approve predictions are indeed accurate, meaning the system can minimize false positives in approval recommendations. Meanwhile, recall of 76.69% shows that the model still has room for improvement in detecting all positive data (Approve). The performance aligns with similar research using SVM for binary classification on medium-sized datasets [22]. Several factors potentially affecting model performance include the relatively small dataset size (n = 133) which may limit the model's generalization capability, absence of parameter tuning such as C and gamma that could optimize SVM performance, and lack of comparison with other algorithms as baseline to measure relative effectiveness. Dataset size limitations represent a common challenge in business machine learning implementations, as also experienced in other SVM classification research [20]. To enhance model performance in the future, several approaches can be implemented such as

increasing training data quantity from longer periods to improve dataset representativeness, experimenting with other SVM kernels like RBF or polynomial that might better suit data patterns, conducting hyperparameter tuning to find optimal configurations, and comparing SVM performance with other algorithms such as Random Forest or K-Nearest Neighbor. Algorithm comparison approaches have proven valuable in selecting the best model [17]. Additionally, implementing more sophisticated imbalanced data handling techniques can help address class imbalance visible from the confusion matrix, following practices successfully applied in medical classification research [25].

5. Conclusion and Recommendations

Based on the implementation and evaluation conducted, the classification model built using SVM algorithm with linear kernel was successfully trained using historical purchase transaction data from SKUS Mart POS system. Features utilized include item quantity, purchase price, old stock, and total purchase amount, selected based on their relevance to PO approval decisions. Model evaluation results demonstrate satisfactory performance with accuracy of 76.69%, precision of 82.21%, recall of 76.69%, and F1-score of 78.51%. These values indicate that the model is sufficiently reliable in classifying PO status as approved or rejected, with high precision showing that positive predictions generated by the model have good accuracy levels. The model was successfully integrated into the CodeIgniter 3-based POS system utilizing local Python scripts through a hybrid approach that enables machine learning model execution from PHP web applications. Classification results are displayed directly on the user interface to support faster and more objective management decision-making processes.

The research provides initial groundwork for integrating machine learning algorithms into goods procurement processes through POS systems, particularly for PO approval processes that were previously manual and subjective. Implementing automatic classification systems can help reduce bias in decision-making and improve consistency in PO approval processes. However, several limitations exist in the study, including relatively small dataset size with 133 data points that may limit model generalization capability, and lack of performance comparison with other algorithms such as Random Forest or K-Nearest Neighbor to determine the best algorithm. For future research, recommendations include increasing historical data volume and variety so models can learn more complex patterns and improve generalization ability. Additionally, hyperparameter tuning and exploration of other SVM kernels such as RBF or polynomial are needed to optimize model performance. Comparing SVM model performance with other classification algorithms as evaluation baseline is also necessary to ensure proper algorithm selection. Adding additional features such as item purchase frequency, lead time, or supplier characteristics can enrich prediction models and improve classification accuracy. With the automatic classification system, companies are expected to enhance operational efficiency and accuracy in goods procurement processes, while reducing dependence on management intuition in PO decision-making. The system can help standardize approval processes and provide more objective recommendations based on historical data, supporting more structured and consistent decision-making in business operations. The implementation demonstrates practical application of machine learning in business process automation, particularly in purchase order management where consistent and data-driven decisions are crucial for operational success.

References

[1] Arman, M., & Maberur, R. (2022). Perancangan aplikasi point of sales pada toko Cahaya Purnama Soppeng. *Jurnal Ilmiah Sistem Informasi dan Teknik Informatika (JISTI)*, *5*(1), 43-50. https://doi.org/10.57093/jisti.v5i1.108

[2] Hanggaraxsha, I., & Gunawan, D. (2024). Aplikasi POS berbasis web terintegrasi dengan WhatsApp pada Fuku Petshop. *The Indonesian Journal of Computer Science*, *13*(2). https://doi.org/10.33022/ijcs.v13i2.3893

[3] Isfahani, R., Firdaus, M. I., & Ibrahim. (2022). *Sistem informasi point of sale pada Point Coffee Banjarmasin berbasis web* [Diploma thesis, Universitas Islam Kalimantan MAB]. https://eprints.uniska-bjm.ac.id/9881/

[4] Nistrina, K., & Rahmania, A. (2021). Sistem informasi point of sale berbasis website studi kasus: PT Barokah Kreasi Solusindo (Artpedia). *J-SIKA: Jurnal Sistem Informasi Karya Anak Bangsa*, *3*(02), 1-12. https://ejournal.unibba.ac.id/index.php/j-sika/article/view/687

[5] Gani, A. G., Dewi, P. F., & Sugiharto, A. (2023). Sistem informasi point of sale berbasis web pada Dapur Caringin Tilu Bandung. *JSI (Jurnal Sistem Informasi) Universitas Suryadarma*, *10*(2), 11-22. https://doi.org/10.35968/jsi.v10i2.1072

[6] Siddik, M., & Samsir, S. (2020). Rancang bangun sistem informasi POS (point of sale) untuk kasir menggunakan konsep bahasa pemrograman orientasi objek. *JOISIE (Journal of Information Systems and Informatics Engineering)*, *4*(1), 43-48. https://doi.org/10.35145/joisie.v4i1.607

[7] Nugraha, P. G. S. C. (2021). Rancang bangun sistem informasi software point of sale (POS) dengan metode waterfall berbasis web. *JST (Jurnal Sains dan Teknologi)*, *10*(1), 92-103. https://doi.org/10.23887/jstundiksha.v10i1.29748

[8] Herdiansyah, A. T., Pratama, A. A., Octavia, I., Baehaqi, R. A. S., Saifudin, A., & Desyani, T. (2021). Perancangan sistem informasi point of sale berbasis website pada Toko Azam Grosir dengan metode waterfall. *Jurnal Informatika Universitas Pamulang*, *6*(2), 388-394. https://doi.org/10.32493/informatika.v6i2.11773

[9] Tundo, Eldina, R., Setiawan, K., & Fajri, R. (2024). Sentiment analysis of cigarette use based on opinions from X using Naive Bayes and SVM. *Jurnal Indonesia: Manajemen Informatika dan Komunikasi*, *5*(3), 2561-2569. https://doi.org/10.35870/jimik.v5i3.947

[10] Akbar, Y., Az-Zahra, H. S., Setiawan, K., & Fajri, R. (2024). Implementation of the Naive Bayes method in Looker Studio for data on the achievement of Great IDN in IDN Akhwat School. *Indonesian Journal of Multidisciplinary Science*, *3*(11). https://doi.org/10.55324/ijoms.v3i11.981

[11] Silviana, S., Astuti, R., & Basysyar, F. M. (2024). Penerapan algoritma support vector machine (SVM) pada ulasan pengunjung wisata Kabupaten Kuningan. *JATI (Jurnal Mahasiswa Teknik Informatika)*, *8*(1), 259-265. https://doi.org/10.36040/jati.v8i1.8257

[12] Yanti, N. P. D. T., & Asana, I. M. D. P. (2023). Sistem klasifikasi pengajuan kredit dengan metode support vector machine (SVM). *Jurnal Sistem Cerdas*, *6*(2), 123-133.

[13] Chairunnisa, C., Ernawati, I., & Santoni, M. M. (2022). Klasifikasi sentimen ulasan pengguna aplikasi PeduliLindungi di Google Play menggunakan algoritma support vector machine dengan seleksi fitur Chi-Square. *Informatik: Jurnal Ilmu Komputer*, *18*(1), 69-79. https://doi.org/10.52958/iftk.v17i4.4594

[14] Triwati, I., Aulia, R., & Haramaini, T. (2025). Implementasi algoritma support vector machine (SVM) pada klasifikasi biaya sumbangan pembinaan pendidikan (SPP) siswa SMA Negeri 1 Na IX-X Aek Kota Batu Labuhan Batu Utara. *Hello World Jurnal Ilmu Komputer*, *3*(3), 146-153. https://doi.org/10.56211/helloworld.v3i3.589

[15] Aprihartha, M. A., Fallo, S. I., & Rasikhun, H. (2025). Perbandingan algoritma real adaptive boosting pada regresi logistik, CART, dan Naive Bayes dalam klasifikasi biji labu. *Jurnal Sains Matematika dan Statistika*, *11*(2), 246-255. http://dx.doi.org/10.24014/jsms.v11i2.36859

[16] Pratama, F., Nasir, M., & Sauda, S. (2020). Implementasi metode klasifikasi dengan algoritma support vector machine untuk menentukan stok persediaan barang pada Koperasi Karyawan Pangan Utama. *Journal of Software Engineering Ampera*, *1*(2), 71-81. https://doi.org/10.51519/journalsea.v1i2.46

[17] Pramansah, V. V., Mulyana, D. I., & Silfia, T. (2022). Analisis perbandingan algoritma SVM dan KNN untuk klasifikasi anime bergenre drama. *Informasi Interaktif*, *7*(2), 101-107.

[18] Mulyana, D. I., & Lutfianti, N. (2023). Penerapan sentimen analisis dengan algoritma SVM dalam tanggapan netizen terhadap berita resesi 2023. *Sisfotenika*, *13*(1), 53-64. http://dx.doi.org/10.30700/jst.v13i1.1339

[19] Septhya, D., Rahayu, K., Rabbani, S., Fitria, V., Rahmaddeni, R., Irawan, Y., & Hayami, R. (2023). Implementasi algoritma decision tree dan support vector machine untuk klasifikasi penyakit kanker paru. *MALCOM: Indonesian Journal of Machine Learning and Computer Science*, *3*(1), 15-19. https://doi.org/10.57152/malcom.v3i1.591

[20] Sabatini, T., & Itan, V. (2024). Implementasi support vector machine untuk klasifikasi kasus monkeypox: Pendekatan oversampling dan undersampling untuk mengatasi ketidakseimbangan kelas. *Journal of Digital Ecosystem for Natural Sustainability*, *4*(1), 38-43. https://doi.org/10.63643/jodens.v4i1.234

[21] Nugraha, Y. R. A. (2021). Implementasi algoritme support vector machine untuk klasifikasi penyesuaian uang kuliah tunggal terdampak pandemi Covid-19 (Studi kasus: Universitas Siliwangi). *JTIK (Jurnal Teknik Informatika Kaputama)*, *5*(2), 210-218. https://doi.org/10.59697/jtik.v5i2.545

[22] Lumbanraja, F. R., Lufiana, F., Heningtyas, Y., & Muludi, K. (2022). Implementasi support vector machine (SVM) untuk klasifikasi penderita diabetes mellitus. *Jurnal Komputasi*, *10*(1), 75-83. https://doi.org/10.23960/komputasi.v10i1.2940

[23] Safitri, D. E., & Fitrani, A. S. (2022). Implementasi metode klasifikasi dengan algoritma support vector machine kernel Gaussian RBF untuk prediksi partisipasi pemilu terhadap demografi Kota Surabaya. *Indonesian Journal of Business Intelligence (IJUBI)*, *5*(1), 36-44. http://dx.doi.org/10.21927/ijubi.v5i1.2259

[24] Abimanyu, S., Bahtiar, N., & Sarwoko, E. A. (2023). Implementasi metode support vector machine (SVM) dan t-distributed stochastic neighbor embedding (t-SNE) untuk klasifikasi depresi. *Jurnal Masyarakat Informatika*, *14*(2), 146-158. https://doi.org/10.14710/jmasif.14.2.59513

[25] Jalil, A., Homaidi, A., & Fatah, Z. (2024). Implementasi algoritma support vector machine untuk klasifikasi status stunting pada balita. *G-Tech: Jurnal Teknologi Terapan*, *8*(3), 2070-2079. https://doi.org/10.33379/gtech.v8i3.4811

[26] Arisona, G., Taruna, A. P., Irwanto, D., Bestari, A. B., & Juniawan, W. (2025). Classification based on the support vector machine for determining operational targets for controlling electricity usage with conventional meters: A case study of industrial and business tariff customers from PT PLN (Persero) Indonesia. *IEEE Access*, *13*, 12388-12398. https://doi.org/10.1109/ACCESS.2025.3529295

[27] Gonzalez-Lima, M. D., Ludeña, C. C., & Otazo-Sanchez, G. G. (2024). A graph classification method based on support vector machines and locality-sensitive hashing. *IEEE Access*, *12*, 15791-15799. https://doi.org/10.1109/ACCESS.2024.3356572.