

https://sinta.kemdiktisaintek.go.id/authors/profile/5981150

SINTA

Author Subjects Affiliations Sources FAQ WCU Regis



RINA FITRIANA

Universitas Trisakti
S1 - Teknik Industri
SINTA ID : 5981150

Industrial Engineering Quality Engineering System Design Information Engineering Management

1.135
SINTA Score Overall

320
SINTA Score 3Yr

1.135
Affi Score

320
Affi Score 3Yr

Articles

Researches

Community Services

IPRs

Books

Metrics



Scopus Garuda Google Scholar RAMA

Scopus Analysis

Quality System Improvement Using Sustainable Lean Manufacturing and Six Sigma in the Heavy Components Industry

Q2 as journal International Journal of Technology

Author Order : 1 of 7 Creator : Fitriana R.

2025 1 cited

The Support Vector Regression Method with the Grid Search Algorithm in Forecasting Sales of Milk Product

Q4 as Book Series Lecture Notes in Mechanical Engineering

Author Order : 2 of 3 Creator : Auliyaanisa N.K.

2025 0 cited

Optimizing Demand Forecasting Method with Support Vector Regression for Improved Inventory Planning

Q3 as journal Jurnal Optimasi Sistem Industri

Author Order : 2 of 4 Creator : Palgunadi T.L.

2024 0 cited

https://sinta.kemdiktisaintek.go.id/authors/profile/6766671

SINTA

Author Subjects Affiliations Sources FAQ WCU Registration Login



ANIK NUR HABYBA

Universitas Trisakti
S1 - Teknik Industri
SINTA ID : 6766671

Konsep Engineering Data Mining Quality Engineering Applied Statistics Industrial Management

822
SINTA Score Overall

268
SINTA Score 3Yr

822
Affi Score

268
Affi Score 3Yr

Articles

Researches

Community Services

IPRs

Books

Metrics



Scopus Garuda Google Scholar RAMA

Scopus Analysis

Optimizing Demand Forecasting Method with Support Vector Regression for Improved Inventory Planning

Q3 as journal Jurnal Optimasi Sistem Industri

Author Order : 3 of 4 Creator : Palgunadi T.L.

2024 0 cited



ISSN: 2442-8795 (online), 2088-4842 (print)

Jurnal Optimasi Sistem Industri



josi.ft.unand.ac.id



Publisher

Industrial Engineering Department, Faculty of Engineering, Universitas Andalas, Padang, West Sumatra, Indonesia

Institution of Engineers Indonesia (Persatuan Insinyur Indonesia)

BKSTI (Badan Kerjasama Penyelenggara Pendidikan Tinggi Teknik Industri)

JOSI

Jurnal Optimasi Sistem Industri

HOME ABOUT - POLICIES - ISSUES -



Editor in Chief
Hilma Raimona Zadry, Ph.D
Industrial Engineering
Department
Andalas University
West Sumatra
INDONESIA



About the Journal

Jurnal Optimasi Sistem Industri (JOSI) with ISSN: 2442-8795 (online medium) and 20188-4842 (print medium), translated as journal on Optimization of Systems in Industries, is a distinguished peer-reviewed. [Read More](#)

Announcements

Volume 23, Issue 2 is Now Live!

2025-02-01

We are pleased to announce that Volume 23, Issue 2 of the Jurnal Optimasi Sistem Industri (JOSI) is now available on our website. We appreciate your patience during our recent server issues, which delayed this publication by a month. Our technical team worked diligently to resolve the problem by migrating to a new server, and we are delighted to have overcome the challenges to bring you this latest edition!

[Read more >](#)

Vol. 23 No. 2 (2024): Published in January 2025 (published late, please read our note) | Jurnal Optimasi Sistem Industri

https://josi.ft.unand.ac.id/index.php/josi/issue/view/14

JOSI

Jurnal Optimasi Sistem Industri

HOME ABOUT - POLICIES - ISSUES -

Home / Archives / Vol. 23 No. 2 (2024): Published in January 2025 (published late, please read our note)

Dear Readers,

This issue has been published several days later than planned. We had originally aimed to release it no later than December 31. However, our server has experienced technical problems since October, and we have been migrating our services to AWS cloud infrastructure. We sincerely apologize for this delay, and we hope it does not affect your interest in reading the research articles published in JOSI.

We warmly invite you to continue submitting your outstanding research work to JOSI.

Sincerely,
Editorial Team

PS. Please check our anomalous traffic at <https://josi.ft.unand.ac.id/index.php/josi/visitors> page/tab 2 in October 2024.

DOI: <https://doi.org/10.25077/josi.v23.n2>
Published: 13-01-2025

ARTICLES

[Towards Safer Workplace: A Survey-Based Study on Developing a Safety Climate Model for the Indonesian Paper Industry](#)

Nana Rahdiana (Universitas Sebelas Maret, Indonesia)
Bambang Suhardi (Universitas Sebelas Maret, Indonesia)
Retno Wulan Damayanti (Universitas Sebelas Maret, Indonesia)
Novri Sumantri (Universitas Diponegoro, Indonesia)
Jafri Mohd Rohani (Universiti Teknologi Malaysia, Malaysia)
DOI: <https://doi.org/10.25077/josi.v23.n2.p130-148.2024>
Page 130-148

DOI: <https://doi.org/10.25077/josi.v23.n2.p130-148.2024>

DOI: <https://doi.org/10.25077/josi.v23.n2.p130-148.2024>

[Optimizing Demand Forecasting Method with Support Vector Regression for Improved Inventory Planning](#)

Tryantomo Lokilmalihul Palgunadi (Universitas Trisakti, Indonesia)
Rina Fitriana (Universitas Trisakti, Indonesia)
Anik Nur Habibi (Universitas Trisakti, Indonesia)
Yun-Chia Liang (Yuan Ze University, Taiwan, Province of China)
DOI: <https://doi.org/10.25077/josi.v23.n2.p149-166.2024>
Page 149-166

DOI: <https://doi.org/10.25077/josi.v23.n2.p149-166.2024>

[A Fuzzy Multi-Criteria Approach for Selecting Open-Source ERP Systems in SMEs Using Fuzzy AHP and TOPSIS](#)

Dana Marseitya Utama (Universitas Muhammadiyah Malang, Indonesia)
Muhammad Faisal Ibrahim (Universitas Semen Indonesia, Indonesia)
Ahmed Nedal Abid Al Kareem Jaber (Palestine Polytechnic University, Palestine, State of)
DOI: <https://doi.org/10.25077/josi.v23.n2.p167-187.2024>
Page 167-187

DOI: <https://doi.org/10.25077/josi.v23.n2.p167-187.2024>

[Enhanced Sustainability Assessment Framework for Plywood Manufacturing: A Multi-Method Approach Using Delphi Technique, BWM, and S-VSM](#)

Amnis Kesy Garside (Universitas Muhammadiyah Malang, Indonesia)
Tyaq Yuli Rosiani (Universitas Muhammadiyah Malang, Indonesia)
Adelya Amanda (Universitas Muhammadiyah Malang, Indonesia)
Thomy Eko Saputro (Universitas Muhammadiyah Malang, Indonesia)
Eduardo e Oliveira (University of Porto, Portugal)
DOI: <https://doi.org/10.25077/josi.v23.n2.p188-206.2024>
Page 188-206

DOI: <https://doi.org/10.25077/josi.v23.n2.p188-206.2024>

[Optimizing the Supply Chain for Recycling Electric Vehicle NMC Batteries](#)

Fransica Indramingsih Kasy (Universitas Sebelas Maret, Indonesia)
Muhammad Hisjam (Universitas Sebelas Maret, Indonesia)
Wakhid Ahmad Jauhari (Universitas Sebelas Maret, Indonesia)
Syed Ahmad Helmi Syed Hassan (Purdue University, United States)
DOI: <https://doi.org/10.25077/josi.v23.n2.p207-226.2024>
Page 207-226

Journal Data

ISSN (Online): 2442-8795

Sinta

Jurnal Optimasi Sistem Industri

Q3 Industrial and Manufacturing Engineering best quartile

SJR 2024 0.17

powered by scimagojr.com

1.0 CiteScore
28th percentile
Powered by Scopus

DOAJ

OPEN ACCESS

License

Articles published in the Jurnal Optimasi Sistem Industri by Industrial Engineering Department, Faculty of Engineering, Universitas Andalas is licensed under CC BY-NC-SA 4.0

Current Issue

DOI: <https://doi.org/10.25077/josi.v23.n2>

Announcements

DOI: <https://doi.org/10.25077/josi.v23.n2>

Vol. 23 No. 2 (2024); Published in January 2025 (published late, please read our note) | Jurnal Optimasi Sistem Industri

https://josi.ft.unand.ac.id/index.php/josi/issue/view/14

Unveiling the Landscape of Sustainable Logistics Service Quality: A Bibliometric Analysis

Shereen Abdellaziz (East Delta Electricity Production Company, Egypt)
Munijati Munawaroh (Universitas Muhammadiyah Yogyakarta, Indonesia)
DOI: <https://doi.org/10.25077/josi.v23.n2.p227-265.2024>
Page 227-265
DOI: <https://doi.org/10.25077/josi.v23.n2.p227-265.2024>

A Solution Approach on Reducing Defects in Batik Tanah Liek Production Process of a Small and Medium-sized Enterprise

Agus Sutanto (Universitas Andalas, Indonesia)
Nilda Tri Putri (Universitas Andalas, Indonesia)
Tessa Alqifti (Universitas Andalas, Indonesia)
Shari Mohd Yusof (Meji University, Japan)
DOI: <https://doi.org/10.25077/josi.v23.n2.p266-282.2024>
Page 266-282
DOI: <https://doi.org/10.25077/josi.v23.n2.p266-282.2024>

Developing an Industry-Specific Lean 4.0 Readiness Assessment Tool: A Case for the Chemical Sector

Arif Budi Sulistyono (Universitas Banten Jaya, Indonesia)
Putu Dara Karningsih (Institut Teknologi Sepuluh Nopember, Indonesia)
Samira Alvaldi (University of Technology Sydney, Australia)
DOI: <https://doi.org/10.25077/josi.v23.n2.p283-298.2024>
Page 283-298
DOI: <https://doi.org/10.25077/josi.v23.n2.p283-298.2024>

JOSI
JURNAL OPTIMASI SISTEM INDUSTRI

CONTACT
Email: editor_josi@eng.unand.ac.id
Phone: (+62) 751 - 72497
Website: josi.ft.unand.ac.id
Address: Redaksi Jurnal Optimasi Sistem Industri, Gedung Jurusan Teknik Industri, Fakultas Teknik Universitas Andalas, Kampus Limau Manis, Jl. Dr. H. Mohammad Hatta, Padang, West Sumatra, Indonesia.

IMPORTANT LINKS
About the Journal
Copyright & License
Submissions
Contact
[ARCHIVE READY](#)

PUBLISHER
Industrial Engineering Department, Engineering Faculty, Universitas Andalas, Padang, West Sumatra, Indonesia
ISSN 2442-8795 (Online)

00365561 | View JOSI's Stat

Editorial Team | Jurnal Optimasi Sistem Industri

https://josi.ft.unand.ac.id/index.php/josi/about/editorialTeam

JOSI
Jurnal Optimasi Sistem Industri

HOME ABOUT - POLICIES - ISSUES -

Home / Editorial Team

Editor in Chief
Hilma Raimona Zadry, Ph.D. Scopus ID: 35338657900, Industrial Engineering Department, Andalas University, West Sumatra, INDONESIA.
Expertise: Human factors and ergonomics in operations

Managing Editor
Dr. Eng. Dicky Fatrias. Scopus ID: 49862953300, Industrial Engineering Department, Andalas University, West Sumatra, INDONESIA.
Expertise: Decision and optimization in socio-technical systems

Editorial Board Members

Assoc. Prof. Ibrahim Kucukkoc Scopus ID: 55637148200, Balikesir University, Balikesir, TURKEY.
Expertise: Design and assets for operations

All Anjomschoe, Ph.D. Scopus ID: 55813103300, Chulalongkorn University, Bangkok, THAILAND.
Expertise: Operations and supply chains

Assoc. Prof. Bruno de Athayde Prata, Scopus ID: 57200302347, Federal University of Ceara, Fortaleza, BRAZIL.
Expertise: Data-driven operations research and analytics

Dr. Wakhid Ahmad Jauhari, Scopus ID: 40761547000, Sebelas Maret University, Central Java, INDONESIA.
Expertise: Operations and supply chains

Prof. Rika Ampuh Hadiguna, Ph.D. Scopus ID: 53877505000, The Institution of Engineers Indonesia, PII - in Indonesia, INDONESIA.
Expertise: Operations and supply chains

Prof. Orhan Korhan, Scopus ID: 35705664600, Eastern Mediterranean University, Famagusta, CYPRUS.
Expertise: Human factors and ergonomics in operations

Assoc. Prof. Indra Gunawan, Scopus ID: 57208820112, The University of Adelaide, South Australia, AUSTRALIA.
Expertise: Design and assets for operations

Make a Submission

Journal Data
ISSN (Online): 2442-8795

Jurnal Optimasi Sistem Industri
Q3 Industrial and Manufacturing Engineering best quartile
SJR 2024 0.17 powered by scimagojr.com

1.0 2024
28th percentile
Powered by Scopus



Editorial Team | Jurnal Optimasi Sistem Industri

https://josi.ft.unand.ac.id/index.php/josi/about/editorialTeam

Expertise: Human factors and ergonomics in operations
Assoc. Prof. Indra Gunawan. Scopus ID: 57208820112. The University of Adelaide, South Australia, AUSTRALIA.
Expertise Design and assets for operations
Assoc. Prof. Tatsuhiko Sakaguchi. Scopus ID: 7202934983. Kindai University, JAPAN.
Expertise Decision and optimization in socio-technical systems
Dr. Wahyudi Setiop. Scopus ID: 42062336300. Cooperation Agency for The Organization of Higher Education in Industrial Engineering, BKSTI - in Indonesian, INDONESIA.
Expertise Operations and supply chain
Dr. Masoud Rahiminezhad Galanakshi. Scopus ID: 57205079270. Imam Khomeini International University, Qazvin, IRAN.
Expertise Decision and optimization in socio-technical systems
Ikhwani Arief, M.Sc. Scopus ID: 57209453335. Cooperation Agency for The Organization of Higher Education in Industrial Engineering, BKSTI - in Indonesian, INDONESIA.
Ambassador to Indonesia and Managing Editor at the Directory of Open Access Journals (DOAJ).
Expertise Data-driven operations research and analytics
Prof. Dradjad Inand, Ph.D. Scopus ID: 7801381167. Institut Teknologi Bandung, West Java, INDONESIA.
Expertise Design and assets for operations
Prof. Ir. Markus Hartono, S.T., M.Sc., Ph.D., CHFP, IPU, ASEAN Eng. Scopus ID: 36055120100. Universitas Surabaya, East Java, INDONESIA.
Expertise Human factors and ergonomics in operations
Dr. Auditya Purwandini Sutarto. Scopus ID: 36997682800. Universitas Qomaruddin Gresik, East Java, INDONESIA.
Expertise Data-driven operations research and analytics
Oyong Novareza, Ph.D. Scopus ID: 55604628800. Brawijaya University, East Java, INDONESIA.
Expertise Design and assets for operations
Insanul Kamit, Ph.D. IPMA. Scopus ID: 56149407000. The Indonesian Chamber of Commerce and Industry, INDONESIA.
Expertise: Industry 4.0/5.0 decision models
Prof. Ir. Nilda Tri Putri, Ph.D. IPU. Scopus ID: 53864158100. Industrial Engineering Department, Andalas University, West Sumatra, INDONESIA.
Expertise Design and assets for operations
Dr. Eng. Suriati Akmal. Scopus ID: 55037766900. Universiti Teknikal Malaysia Melaka, Melaka, MALAYSIA.
Expertise Design and assets for operations
Mirta Widia, Ph.D. Scopus ID: 35797800000. Universiti Malaysia Pahang, Pahang, MALAYSIA.
Expertise Human factors and ergonomics in operations
Prof. Feri Afrinaldi, Ph.D. Scopus ID: 35748506100. Industrial Engineering Department, Andalas University, West Sumatra, INDONESIA.
Expertise Design and assets for operations
Jonnimaldi, Ph.D. Scopus ID: 36915229700. Cooperation Agency for The Organization of Higher Education in Industrial Engineering, BKSTI - in Indonesian, INDONESIA.
Expertise Data-driven operations research and analytics
Iskandar Hasanuddin, Ph.D. Scopus ID: 57203218451. Universitas Syiah Kuala, Aceh, INDONESIA.
Expertise Design and assets for operations
Prof. Dwi Agustina Kurniawati, Ph.D. Scopus ID: 57199505227. Universitas Islam Negeri Syarif Hidayatullah, Yogyakarta, INDONESIA.
Expertise Operations and supply chain
Dr. Eng. Lusi Susanti. Scopus ID: 24598207800. Industrial Engineering Department, Andalas University, West Sumatra, INDONESIA.
Expertise Human factors and ergonomics in operations

DOAJ
OPEN ACCESS

License
Articles published in the *Jurnal Optimasi Sistem Industri* by Industrial Engineering Department, Faculty of Engineering, Universitas Andalas is licensed under [CC-BY-NC-SA 4.0](#)

Current Issue
• [Vol. 10 No. 1](#)
• [Vol. 10 No. 2](#)
• [Vol. 10 No. 3](#)

Announcements
• [Vol. 10 No. 1](#)
• [Vol. 10 No. 2](#)
• [Vol. 10 No. 3](#)

JOSI
JURNAL OPTIMASI SISTEM INDUSTRI

CONTACT
Email: editor_josi@eng.unand.ac.id
Phone: (+62) 751 - 72497
Website: josift.unand.ac.id
Address: Redaksi: Jurnal Optimasi Sistem Industri, Gedung Jurusan Teknik Industri, Fakultas Teknik Universitas Andalas, Kampus Limau Manis, Jl. Dr. H. Mohammad Hatta, Padang, West Sumatra, Indonesia.

IMPORTANT LINKS
About the Journal
Copyright & License
Submissions
Contact
[ARCHIVE READY](#)

PUBLISHER
Industrial Engineering Department, Engineering Faculty, Universitas Andalas, Padang, West Sumatra, Indonesia
ISSN 2442-8795 (Online)

 View JOSI's Stat
00365561

Accreditation Decree | Jurnal Optimasi Sistem Industri

https://josi.ft.unand.ac.id/index.php/josi/decree

JOSI
Jurnal Optimasi Sistem Industri

HOME ABOUT - POLICIES - ISSUES -

Accreditation Decree

Jurnal Optimasi Sistem Industri is certified as a Grade 1 (Sinta 1) accredited journal by the Indonesian Ministry of Research, Technology and Higher Education (No. 169/E/KPT/2024).

**KEMENTERIAN PENDIDIKAN, KEBUDAYAAN, RISET DAN TEKNOLOGI
DIREKTORAT JENDERAL PENDIDIKAN TINGGI, RISET, DAN TEKNOLOGI**
Jalan Jenderal Sudirman, Senayan, Jakarta 10270
Telepon (021) 57946104, Pasar Panggilan ULT DIKTI 126
Laman www.dikti.kemendikbud.go.id

Nomer : 1438/E5/DT.05.00/2024
Lampiran : 1 (satu) berkas
Hal : Pemberitahuan Peringkat Akreditasi Jurnal Ilmiah yang Terindeks
Bereputasi Internasional Periode 1 Tahun 2024

13 November 2024

Yth.
1. Pimpinan Perguruan Tinggi
2. Koordinator LLDikti I s.d. XVI
3. Ketua Himpunan Profesi
4. Pengelola Jurnal Ilmiah
di seluruh Indonesia

Journal Data
ISSN (Online): 2442-8795

sinta
Jurnal Optimasi Sistem Industri
Q3 Industrial and Manufacturing Engineering best quartile
SJR 2024 0.17
powered by scimagojr.com

1.0 2024
20th percentile
Powered by Scopus

DOAJ

Sehubungan dengan terindeksnya jurnal Indonesia pada lembaga indeksasi bereputasi internasional dan pemberian pengakuan sebagai Peringkat 1 (Sinta 1) maka diterbitkan Surat Keputusan Direktur Jenderal Pendidikan Tinggi, Riset, dan Teknologi Nomor 169/E/KPT/2024, tanggal 1 Oktober 2024 tentang Peringkat Akreditasi Jurnal yang Terindeks Bereputasi Internasional Periode I Tahun 2024, dengan hormat bersama ini kami sampaikan hasil akreditasi sebagaimana terlampir. Adapun ketentuan penerbitan sertifikat akreditasi sebagai berikut:

1. Jurnal ilmiah di Indonesia yang sebelumnya telah terakreditasi di Sinta bukan di Peringkat 1 namun tercantum pada Surat Keputusan Direktur Jenderal Pendidikan Tinggi, Riset, dan Teknologi Nomor 169/E/KPT/2024 akan diberikan peringkat baru menjadi Peringkat 1.
2. Bagi jurnal ilmiah yang belum terakreditasi namun tercantum pada Surat Keputusan poin 1 akan diberikan status sebagai Peringkat 1 dan diwajibkan mengajukan akreditasi jurnalnya



License

Articles published in the [Jurnal Optimasi Sistem Industri](#) by [Industrial Engineering Department, Faculty of Engineering, Universitas Andalas](#) is licensed under [CC BY-NC-SA 4.0](#)

Current Issue

- [Volume 1, Issue 1, 2024](#)
- [Volume 1, Issue 2, 2024](#)
- [Volume 1, Issue 3, 2024](#)

Announcements

- [Volume 1, Issue 1, 2024](#)
- [Volume 1, Issue 2, 2024](#)
- [Volume 1, Issue 3, 2024](#)

PUBLISHER

Industrial Engineering Department, Engineering Faculty, Universitas Andalas, Padang, West Sumatra, Indonesia

ISSN 2442-8795 (Online)



00365561 [View JOSI's Stat](#)



Jurnal Optimasi Sistem Industri (JOSI) translated as: Journal on Optimization of System at Industries (JOSI) is a peer-reviewed [open access](#) scholarly periodical. JOSI publishes research papers, technical papers, conceptual papers, and case study reports.

CONTACT

Email: editor_josi@eng.unand.ac.id

Phone: (+62) 751 - 72497

Website: josi.it.unand.ac.id

Address: Redaksi Jurnal Optimasi Sistem Industri, Gedung Jurusan Teknik Industri, Fakultas Teknik Universitas Andalas, Kampus Lima Manis, Jl. Dr. H. Mohammad Hatta, Padang, West Sumatra, Indonesia.

IMPORTANT LINKS

[About the Journal](#)

[Copyright & License](#)

[Submissions](#)

[Contact](#)





Research Article

Optimizing Demand Forecasting Method with Support Vector Regression for Improved Inventory Planning

Tryantomo Lokhilmahful Palgunadi ^a, Rina Fitriana ^{a,*}, Anik Nur Habyba ^a, Yun-Chia Liang^b

^a Department of Industrial Engineering, Universitas Trisakti, Jakarta, Indonesia

^b Department of Industrial Engineering and Management, Yuan Ze University, Taoyuan, Taiwan

* Corresponding Author: rinaf@trisakti.ac.id

© 2025 Authors

DOI: [10.25077/josi.v23.n2.p14.9-166.2025](https://doi.org/10.25077/josi.v23.n2.p14.9-166.2025)

Submitted : June 3, 2024;

Accepted : November 16, 2024;

Published : January 30, 2025

ABSTRACT

Problems arising from suboptimal production planning can cause inventory management to be less effective and efficient in the company. The lack of integrated presentation of information also causes less efficiency in making decisions. This study aims to obtain the best kernel function forecasting model by predicting ground rod sales using the Support Vector Regression (SVR) method in order to determine the level of forecasting accuracy and the results of ground rod forecasting in the future which are presented in an optimal data visualization. This problem-solving is done with the Support Vector Regression method, which consists of linear kernel functions, polynomial kernel functions, and radial basis function (RBF) kernel functions with the Grid Search Algorithm. Based on the results of the best parameter search that has been done using the grid search algorithm, it can be concluded that the best kernel function forecasting model is a linear kernel function with a value of $C = 100$ and $\epsilon = 10^{-3}$. The accuracy of this forecasting model has a MAPE value of training data and testing data of 2.048% and 1.569%, where this value is the smallest MAPE value compared to the MAPE value of the other two functions. After getting the best model, forecasting was carried out within five months, obtaining an average of 6,647 monthly pieces. The results of forecasting and historical sales are reviewed in a visualization of Business Intelligence data so that it is well exposed, where the forecasting shows an increase from every month.

Keywords: Support Vector Regression (SVR), forecasting, grid search algorithm, Kernel functions, business intelligence

INTRODUCTION

In the development of the current technological age, the manufacturing industry has been considered one of the critical factors in developing countries, just like the manufacturing process both domestically and internationally in the industrial sector that has higher competition in meeting consumer demand with a reasonably volatile market. Therefore, production and inventory efficiency are critical aspects of the operations of a manufacturing company that affect overall performance. Demand forecasting plays an important role as a decision-support tool in industrial system management [1]. This study emphasizes effective forecasting supports broader industrial objectives, like efficiency in resource use and operational sustainability [2]. Efficiency in inventory management is essential to control production costs and maintain adequate product availability for consumers. In the context of competitive business and fluctuating markets, manufacturing companies such as XYZ Co. are faced with demands to optimize their inventory management to achieve market production targets, especially in ground rod products. Demand for goods by customers tends to change and be uncertain. From 2021 to 2023, it can be seen that sales for ground rod

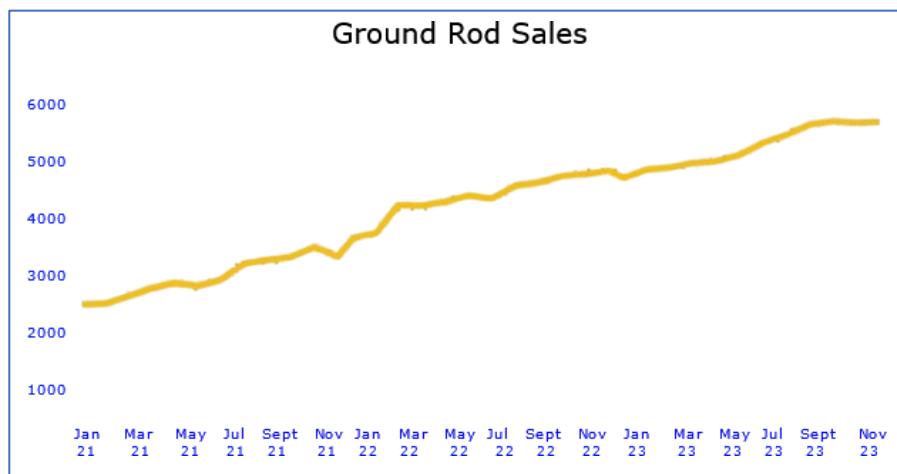


Figure 1. Ground rod sales graph in 2021-2023.

products fluctuates, but there tends to be an increase (Figure 1). The company XYZ Co. often finds it difficult to predict future demand, so this also results in less efficient ground rod stock. Starting from the ineffectiveness of forecasting methods, the problems resulting from this problem, apart from ineffective inventory stock, also impact production costs, overtime costs, and raw material ordering costs.

In addition to optimizing inventory management, manufacturing companies must also be able to produce products with qualities that follow national standards. This is done so that manufacturing companies are concerned not only with quantity or quality but because these two things are essential for the company's sustainability. Quality management is essential for companies because it directly impacts customer satisfaction and loyalty [3]. Thus, the company has noticed that quality is critical for developing products and services to drive sustainable achievement in previous research [4]. The sales they get results vary greatly, which means that different subjects are likely to have different data values for the same variable, and thus, the data values vary from subject to subject, which is the same as the previous study [5]. These changes in demand significantly affect the ground rod inventory owned by the company. Determination of ground rod inventory is done by comparing the number of items sold in the last month with the number of items that came out in the current month. This condition can impact production quality later, so if too much demand is not as predicted, the performance in producing ground rods will decrease [6]. The forecasting function is used to forecast the inventory of goods to be more precise based on past and future conditions. Forecasting is the science of predicting every event that will occur using past or historical data, which is processed and then projected into the future with a mathematical model [7]. So, based on these problems, this study uses forecasting methods to predict the inventory of goods that the company must prepare in the future. The method that can be used in this study is the quantitative forecasting method, which is a forecast based on quantitative data or mathematical models that vary with past data. In quantitative forecasting methods, there are three types of time-based forecasting methods, namely long-term (> two years), medium-term (3 months – 2 years), and short-term (0 – 3 months) [8]. In this case study, the forecasting method is the Support Vector Regression (SVR).

Machine learning methods such as Support Vector Regression (SVR) and kernel functions have been proposed to replace statistical methods in more recent sales predictions [9]. SVR has advantages in handling nonlinear problems with high dimensions and small samples [10]. It is based on statistical learning theory and structural risk minimization principles. SVR has become a popular and effective load prediction method in recent years. This is especially noticeable in research and practice, especially in operational research, where linear optimization techniques led in operational research are used to find optimal solutions to nonlinear prediction problems in larger-

dimensional feature spaces [11]. The research used Support Vector Regression; we were able to model prediction models well for COVID-19 cases [12]. Then research [13][14] was also carried out using the SVR method to predict exchange rates/currency indices and stock indices so that SVR can be implemented in many objects, one of which is the sale of XYZ Co. products. This research approach was unique because combines the Support Vector Regression (SVR), the grid search algorithm, and power business intelligence for visualization data, bringing a new level of accuracy or efficiency to forecasting that wasn't addressed in previous studies.

This manufacturing company had problems planning Ground Rod production due to the lack of implementation of the forecasting method used. The company had only used a track record of every demand for ground rod products in the previous period, where the results still need to be optimal for predicting demand in the future. One of the impacts caused by this problem is the increase in company costs in providing overtime for employees. This research was conducted to optimize forecasting methods using support vector regression at XYZ Co. By proposing the forecasting model used, the company is expected to increase efficiency in ground rod product inventory management and minimize production costs at XYZ Co. Display visualization, recapitulation and data planning can also help companies carry out actions and decisions to maintain stability.

Forecasting is a process of forecasting future conditions using data from the past. Demand forecasting is essential for many companies because it determines production planning, inventory, and many other aspects of operations [9]. By using demand forecasting, the risks that occur in inventory control can be minimized. Demand forecasting helps businesses make decisions. The prediction of goal demand is divided into short-term and long-term. Short- run examples include production policies, pricing, sales controls, and finance, while long-term examples include determining production capacity [15]. A critical aspect of choosing a forecasting method is to look at patterns from the observed data. The prediction introduces four kinds of patterns: [16] cyclist pattern, horizontal pattern, trend pattern, and seasonal pattern. Support Vector Machine (SVM) is a mighty machine learning algorithm developed for classification and prediction problems, which works by recognizing patterns through kernel tricks. Due to its high performance and excellent generalizability compared to other classification methods, SVM methods are widely used in bioinformatics, text and image recognition, and finance, and one of them is prediction. This method finds the linear boundary (hyperplane) representing the most significant margin between two classes (labels) in the input space. This method can be applied not only to linear data but also to nonlinear data by using kernel functions [17]. Although first created to solve classification problems, regression work can also be handled using predictive analytics [18]. Support Vector Regression is an adaptation of support machine learning based on the classification of regression models from Support Vector Machine (SVM) [19]. SVR is a method that can solve nonlinear estimation problems. SVR successfully predicts time series data as well as time series financial data. According to Cortez and Vapnik [20], SVR uses linear models to be applied to nonlinear classes by mapping the input vector x into a high- dimensional feature space. SVR works by finding the maximum margin of the hyperplane and looking for the most minor error. The data closest to the maximum margin of the hyperplane is called the support vector [21]. Suppose the visualized data plot is feasible or feasible. In that case, a perfect regression will be obtained. However, suppose there is inappropriateness or $\varepsilon = 0$ infeasibility, where several points are out of the range or threshold. In that case, slack variables ξ and ξ^* will be added to optimize existing errors. This explanation can be seen in Figure 2.

In general, the SVM equation is shown by equation [21]:

$$f(x) = w^T \varphi(x) + b \quad (1)$$

where w is the weight factor, b is the threshold, and $\varphi(x)$ is a function that maps input x into the feature space. To minimize the defined risk function can be done by estimating the coefficients w and b with the following equation:

$$\min_{w, b} \frac{1}{2} \|w\|^2 + C \sum_{i=1}^n (\xi_i + \xi_i^*) \quad (2)$$

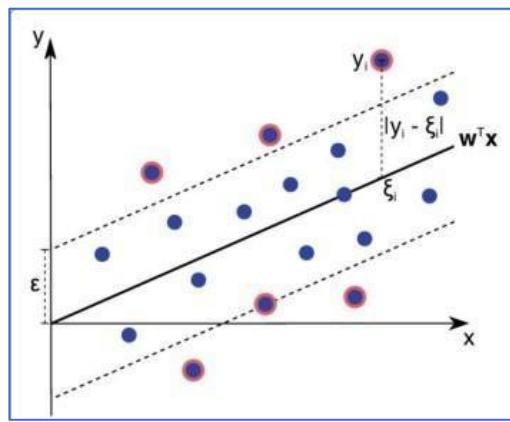


Figure 2. Support vector regression

Subject to:

$$y_i - \langle w\varphi(x_i) \rangle - b \leq \varepsilon \varepsilon + \xi \quad (3)$$

$$\langle w\varphi(x_i) \rangle + b - y_i \leq \varepsilon \varepsilon + \xi^* \quad (4)$$

$$\xi, \xi^* \geq 0 \quad (5)$$

In the equation above, the constant C has the conditions $C > 0$, which determines the trade-off between the flatness of the function f and the limit $\varepsilon \varepsilon$ (epsilon). At the same time, the factor $\|w\|^2$ is also called regularization [20]. Any point or coordinate value outside the limit will be multiplied by C . Assigning a significant value of C means emphasizing the factor's importance over the function's flatness factor. Figure 3 graphically illustrates the situation by adding slack ξ^* and modifiers ξ . The slack variable located in the interval will be zero, and the farther the distance of the slack variable to the limit, the greater the value. Support vectors are points in the training data located exactly below and outside the boundary line. The smaller the accuracy value, the higher the number of $\varepsilon \varepsilon$ support vectors, and the higher the value of the slack modifier.

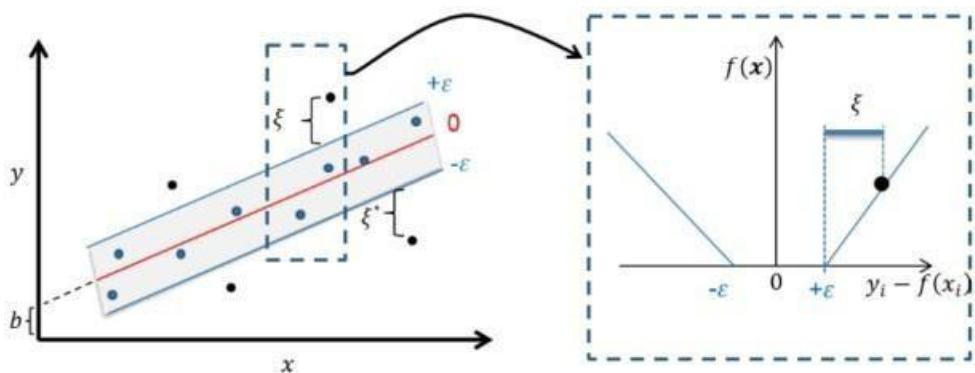


Figure 3. Random modifier illustration.

To solve this regression problem, the internal product of equation (1) can be replaced with the kernel function $K()$. This allows performing such operations in larger dimensions with low-dimensional space data input without knowing the transformation φ [23], as shown in equation (6). These are called kernel functions:

$$f(x) = \sum_{i=1}^N (\alpha^* - \alpha) \cdot K(x_i, x_{jj}) + b \quad (6)$$

The optimal squared problem associated with binder Lagrange α^* and α . SVR uses a kernel to connect data to a more prominent feature space, enabling more structured data processing and more efficient computation. Kernel functions in SVR have more precision than standard linear SVR in nonlinear regression [22]. This study uses three types of kernel functions: linear kernels, polynomial kernels, and Radial Basis Function (RBF) kernels. The formula of the three Kernel functions is as follows [23]:

- Kernel Linear

$$K(x_i, x_{jj}) = x_i^T x_{jj} \quad (7)$$

with the pairing of two data in the x_i, x_{jj} training data

- Kernel Polynomial

$$K(x_i, x_{jj}) = (x_i^T x_{jj} + 1)^d, d > 1 \quad (8)$$

where d is the degree of the required parameter

- Kernel Radial Basis Function

$$K(x_i, x_{jj}) = \exp(-\gamma \gamma \|x_i - x_{jj}\|^2) \quad (9)$$

METHODS

Figure 4 explains the stages in this research, which include problem identification, literature studies and field studies, data collection, data preprocessing, parameter tuning with grid search, SVR forecasting with kernel functions, validation with MAPE and R^2 , predicting ground rod requests, and also visualizing data with Power BI.

Problem Identification

At this stage, an identification of the problems to be solved in this research will be identified. This study's problem is the demand for ground rod products at XYZ Co. This research will forecast sales or demand for ground rods at XYZ Co. to prevent overtime, additional production costs, or other costs.

Literature Studies and Field Studies

At this stage, several literature reviews will be discussed that support the work of this research. The literature used includes international journals, books, and national journals that dissect the topics determined in this study. At this stage, the results are research concepts and methods, namely the SVR method with the Grid Search Algorithm to find optimal parameters.

Data Collection

At this stage is to collect data. The data collected is ground rod sales data from XYZ Co. from 2021 to 2023.

Preprocessing Data

This stage is the stage after the data is obtained. This stage is the data preprocessing stage, where the data used for making models, namely XYZ Co. ground rod sales data, will be divided into training data and testing data with a proportion of 80% of the total observation data for training data and 20% observation data for test data. From the total data, 36 data, 28 training data, and eight testing data were obtained. Before the separation between test data and training data, preprocessing was carried out in the form of analyzing raw data by mapping and grouping data into periods per month, then checking null descriptive data from all ground rod product observation data at XYZ

Co., which was processed using Python language.

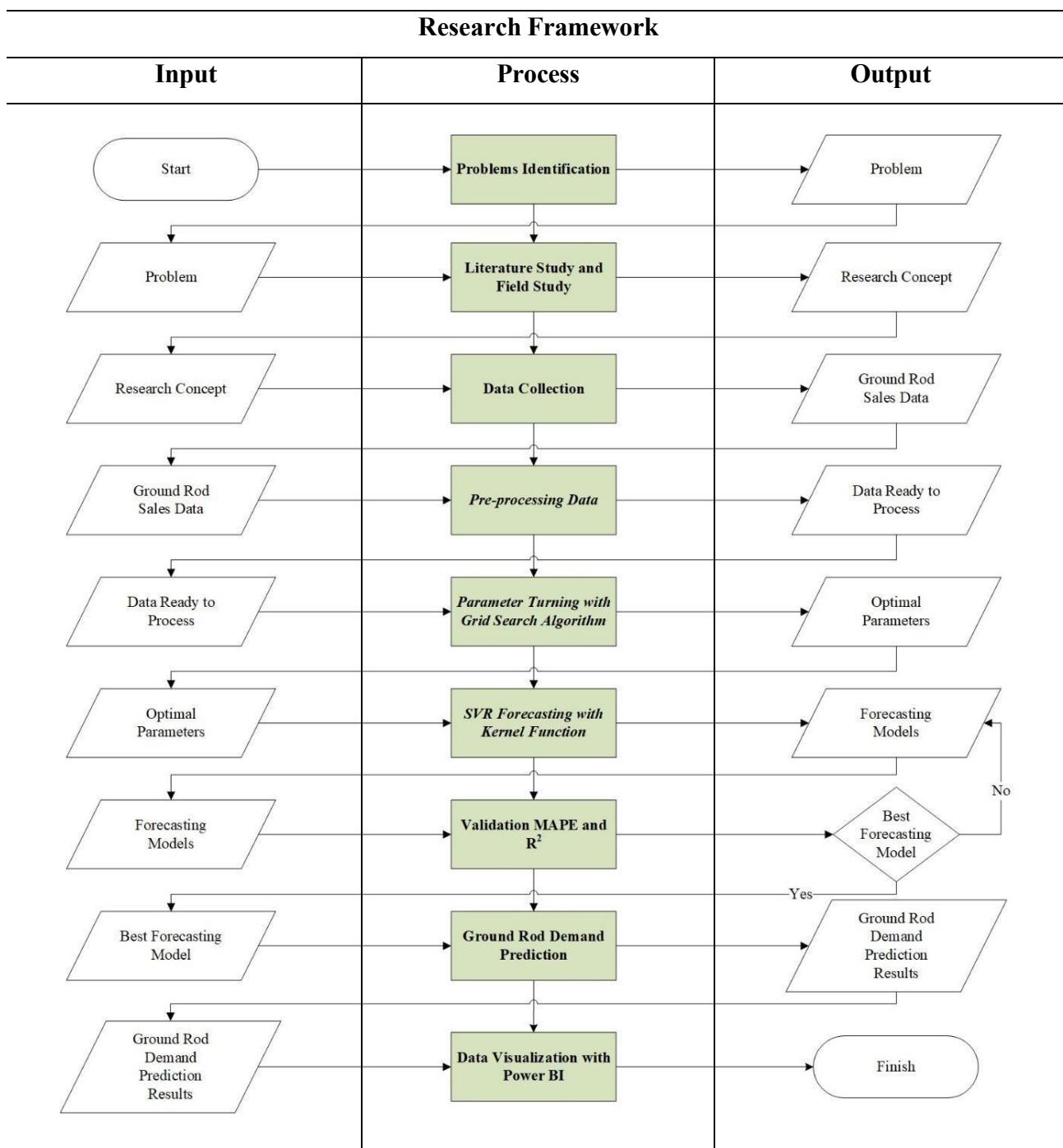


Figure 4. Research framework

Parameter Tuning with Grid Search Algorithm

The Grid Search algorithm can be used to find the ideal parameters. This Algorithm divides the range of parameters to be optimized into grids and traverses each point to obtain the ideal parameters. In its applications, various performance metrics must control grid search algorithms, which are usually measured through cross-validation tests on training data. Therefore, it is recommended to try several parameter pairs on the SVR hyperplane [26]. The parameter pair that results in the most accurate cross-validation test is the best. The cross-validation method is used when selecting model combinations and hyperparameters that automatically validate each combination [26]. The optimal pair of hyperparameters has the most minor error value and the highest accuracy.

Table 1. MAPE Descriptions

MAPE	Description
< 10%	The ability of the forecasting model is excellent
10% - 20%	The ability of the forecasting model is good
20% - 50%	The ability of the forecasting model is quite decent
> 50%	The ability of the forecasting model is terrible

Forecasting and Support Vector Regression

Forecasting uses the Support Vector Regression (SVR) algorithm with kernel functions. SVR is a machine learning algorithm used for forecasting and classification. Kernel functions convert input data into higher feature spaces to be separated appropriately. Some commonly used types of kernel functions are linear, polynomial, and radial basis functions (RBF). This study will determine the kernel functions used in SVR using these three kernel functions in Equation (7)-(9).

Validation Measurement with MAPE and R²

The error is usually calculated using Mean Absolute Deviation (MAD), Mean Squared Error (MSE), and Mean Absolute Percentage Error (MAPE). The MAPE description is presented in Table 1. Mean absolute error is the average of the absolute values of forecasting errors. Mean squared error is the average of forecasting errors squared. The mean absolute percentage error is the percentage of error of experience [27]. However, MAPE will be used in this study. Here is the equation:

$$MAPE = \frac{1}{n} \sum_{i=1}^n \frac{|e_i|}{D_i} \times 100\% \quad (10)$$

$$\frac{n}{i=1} \frac{|e_i|}{D_i} \times 100\%$$

where:

$$\begin{aligned} e_i &= F_t - D_t && \text{Forecast errors} \\ F_t & && \text{Forecast value} \\ D_t & && \text{Actual value} \\ t & && \text{Period} \end{aligned}$$

The coefficient of determination (R^2) is an accuracy metric that indicates the magnitude of the dependent variable in the model [26]. It ranges from zero to one or zero to one hundred percent. A good coefficient of determination is a value close to one. Here is the equation:

$$R^2 = 1 - \frac{\sum_{i=1}^n (F_t - D_t)^2}{\sum_{i=1}^n (D_t - \bar{D}_t)^2} \quad (11)$$

In the study [29], it was further explained as follows:

- $R^2 \geq 0$ means that with linear regression without constraints, R^2 is non-negative and corresponds to the square of the double correlation coefficient.

- $R^2 = 0$ means that the attached line (hyperplane) is horizontal. With two numerical variables, this happens if the variables are independent of each other (independent) or uncorrelated.
- $R^2 < 0$ means that this case is only possible with linear regression when the intercept or slope is delimited so that the "most suitable" line (given its constraints) is worse than the horizontal line, for example, if the

regression line (hyperplane) does not follow the data. Table 2 shows the categories of R^2 .

Table 2. R^2 Categories

R^2	Description
0,75 - 1	Strong Category
0,50 - 0,75	Moderate Category
0,25 - 0,50	Weak Category
< 0,25	Very Weak Category

Data visualization with Power Business Intelligence (BI)

Business Intelligence (BI) is the application of available mathematical models and data analysis methodologies to obtain relevant information and knowledge in the face of complex decisions. This system acts as a tool that provides accurate and valuable information to decision-makers within a specific time limit, thus supporting the decision-making process in the dairy industry [30]. Power BI is a cutting-edge business intelligence and data visualization platform developed by Microsoft. It empowers organizations and individuals to turn raw data into valuable insights and visually appealing reports and dashboards [31]. Power BI has advantages in ease of use, integration with various data sources, and flexibility in creating attractive visualizations. In addition, business intelligence can recognize unstructured data, improve product quality, and create new opportunities in business strategy [32]. The use of BI offers several benefits that can speed up decision-making, such as [33] creating dashboards and performance measurement metrics in the era of automation and acceleration. A focus on business attention on key customers and channels that drive desired results, measure performance against established performance measurement goals and can influence management with exclusion strategies.

RESULT AND DISCUSSION

Step 1: Preprocessing Data

After the data is obtained on the observation results, data processing is carried out. The data that serves to create the model is historical data on sales of XYZ Co. ground rod products, divided into training sets and test sets. The training data and test data are divided by the proportion of 80% as training data from all observation data and 20% as test data. For each variable, 28 training data and 8 test data were obtained from a total of 36 data obtained. Training data has more testing data so that machine learning models can learn, shape, and create the best models [34][35]. Before the separation between test data and training data, preprocessing was carried out in the form of analyzing raw data by mapping and grouping data into periods per month, then checking null descriptive data from all ground rod product observation data at XYZ Co. which was processed using python language which results are presented in Table 3.

Descriptive statistics provide an overview of the sample under study without concluding based on probability theory. Descriptive statistics provide a general overview, although the study's primary purpose is inferential statistics. Descriptive statistics describes a population using tools such as frequency tables, percentages, and other measures of central tendency such as mean [36]. The information provided in Table 3 is a descriptive statistical table containing several central measurements such as the amount of data (n), mean, minimum value, maximum value, and standard deviation. The mean is the arithmetic mean of the sum of the data values divided by the number of observations,

Table 3. Descriptive Statistics

n	Mean	Minimum	Maxsimum	Std. Deviation
36	4117.44	2611	5444	898.52

one measure of central tendency. The standard deviation of a distribution can be used to describe its spread. In other words, standard deviation expresses how close each observed value is to the mean [37]. The information shows an interpretation that the most significant ground rod sales over the last three years experienced by XYZ Co. were 5444 pieces in December 2023, while the most miniature ground rods ever experienced by XYZ Co. were 2611 pieces in January 2021. Then, the average sales of ground rod products from XYZ Co. from 2021 to 2023 were obtained at 4117.4 or around 4117 pieces with a standard deviation of 898.52. Although demand or sales over the past three years at XYZ Co. are not easy to predict, the company has shown growth in sales of ground rod products over the last three years.

Step 2: Parameter Tuning with Grid Search Algorithm

Before building a prediction model with the Support Vector Regression (SVR) method, parameter tuning is done to get optimal parameters for building the model. The Grid Search algorithm is used to find the best combination of parameters by iterating over all possible combinations of predefined parameters [38]. Parameter tuning is carried out using the core parameters of each SVR algorithm. The process of obtaining optimal parameters of kernel functions is carried out using the grid search algorithm. In searching for optimal parameters, tuning parameters are used, which, as SVR input, are the values of C (cost), γ (gamma), d (degree), and ϵ (epsilon). SVR parameter search with a Grid search Algorithm divides the range of parameters to be optimized into grids and across each point to get the ideal parameter. Parameter tuning is done for each kernel using the Grid search CV function in the sklearn model selection library in Python software. The grid search must also be readjusted to the kernel that is being used. In linear kernels, grid search is used in finding optimal parameters of the constants C and ϵ (epsilon). While in the polynomial kernel, grid search is used to find and optimize parameters with constants C , ϵ , and d (degree). Then in the Radial Basis Function (RBF) kernel, grid search functions as searching and optimizing parameters with constants C , ϵ , γ (gamma). In determining the magnitude of the γ parameters influenced from each data point in the input space mapping to higher dimensions.

The values of the parameters used in the three kernel functions vary. Table 4 describes how the grid search algorithm is performed in stages. Starting from input in the form of time series data, which is then processed using a grid search by entering predetermined parameters, then the best parameter search process with 'gridsearch best estimator'. After obtaining the optimal parameters, predictions are made with the model (M_i) set to see the value of the evaluation metric (Mean Absolute Percentage Error). After MAPE validation has been performed and valid, the model (M_i) is ready to be used as a prediction model. Table 5 shows that in linear kernel functions, the C and ϵ

Table 4. Computational Design Grid Search Algorithm

Algorithm	: Algorithm design for grid search to find the best testing models.
Input	: training time series (R); testing time series (T)
Output	: the best parameters with minimum testing error (BTM)
FindBestTestingModels (R, T)	
	<pre> foreach $C \in \{10^{-1}, 1, \dots, 100\}$; $\epsilon \in \{10^{-3}, 10^{-2}, 10^{-1}\}$; $\gamma \in \{10^{-5}, 10^{-4}, \dots, 10^{-1}\}$; $d \in \{2, 4\}$ do P \leftarrow Use the best parameter grid estimator. M_i \leftarrow Make the i-th model with parameters P Train M_i with R F_i \leftarrow Predict using the trained model M_i $MAPE_i$ \leftarrow MAPE between the predicted (F_i) and the original testing data (F) BTM_i \leftarrow add the best model M_i return BTM </pre>

Table 5. Kernel Function Parameter Values

No.	Kernel Functions	Parameter Hyperplane	Parameter Value
1	Kernel Linear	C	$10^{-1}, 1, 10, 100$
		$\varepsilon\varepsilon$	$10^{-3}, 10^{-2}, 10^{-1}$
2	Kernel Polynomial	C	$10^{-1}, 1, 10, 100$
		$\varepsilon\varepsilon$	$10^{-3}, 10^{-2}, 10^{-1}$
		d	2, 4
3	Kernel Radial Basis Function (RBF)	C	$10^{-1}, 1, 10, 100$
		$\varepsilon\varepsilon$	$10^{-3}, 10^{-2}, 10^{-1}$
		$\gamma\gamma$	$10^{-5}, 10^{-4}, 10^{-3}, 10^{-2}, 10^{-1}$

parameters used are as high as $10^{-1}, 1, 10, 100$ and $10^{-3}, 10^{-2}, 10^{-1}$. Then, in the linear kernel function, the parameters C , $\varepsilon\varepsilon$, and d used are $C = 10^{-1}, 1, 10, 100$, then $\varepsilon\varepsilon = 10^{-3}, 10^{-2}, 10^{-1}$, and $d = 2, 4$. Next, in the Radial Basis Function (RBF) kernel, the parameters C , $\varepsilon\varepsilon$, and $\gamma\gamma$ used are $C = 10^{-1}, 1, 10, 100$, $\varepsilon\varepsilon = 10^{-3}, 10^{-2}, 10^{-1}$, and $\gamma\gamma = 10^{-5}, 10^{-4}, 10^{-3}, 10^{-2}, 10^{-1}$. Of the various parameters that have been determined, the best parameter search process will be carried out using the grid search algorithm so that the model can run optimally on each kernel function.

Step 3: MAPE and R² Kernel Function Validation

After tuning the parameters using the grid search algorithm, the next step is to perform and run the model on each kernel to see which of each prediction will later be selected as the best prediction model. These parameters are passed into the SVR model in Python. After obtaining the prediction model, the results are interpreted in Table 6.

After searching for the best parameters using the grid search algorithm, it can be seen in Table 4 that the best parameter results obtained in linear kernel functions are $C = 100$ and $\varepsilon\varepsilon = 10^{-3}$ with MAPE values of training data and testing data produced are 2.048% and 1.569% [37]. Then, the best parameter results obtained in polynomial kernel functions are $C = 1$, $\varepsilon\varepsilon = 10^{-3}$, and $d = 2$. Training data and testing data produced are 2.705% and 2.430%. Furthermore, the Radial Basis Function (RBF) kernel function obtained the best parameter results with values of $C = 100$, $\varepsilon\varepsilon = 10^{-3}$, and $\gamma\gamma = 10^{-5}$ training data and testing data produced were 5.777% and 24.917%. Based on the results of the best parameter search that has been done using the grid search algorithm, it can be concluded that the best kernel function that can be used as a prediction model is a linear kernel function with a value of $C = 100$ and $\varepsilon\varepsilon = 10^{-3}$, which has a MAPE value of training data and testing data by 2.048% and 1.569% where these values are the smallest MAPE values compared to MAPE values in polynomial kernel functions and radial base function kernel functions. Therefore, it can be said that linear kernel functions have prediction values with the smallest error rate compared to

Table 6. Best Parameter Values of Kernel Functions

No.	Kernel Function	Parameter Hyperplane	The Best Parameter Value	MAPE Value (%)	
				Training Data	Testing Data
1	Kernel Linear	C (cost)	100	2,048	1,569
		$\varepsilon\varepsilon$ (epsilon)	10^{-3}		
2	Kernel Polynomial	C (cost)	1	2,705	2,430
		$\varepsilon\varepsilon$ (epsilon)	10^{-3}		
		d (degree)	2		
3	Kernel Radial Basis Function (RBF)	C (cost)	100	5,777	24,917
		$\varepsilon\varepsilon$ (epsilon)	10^{-3}		
		$\gamma\gamma$ (gamma)	10^{-5}		

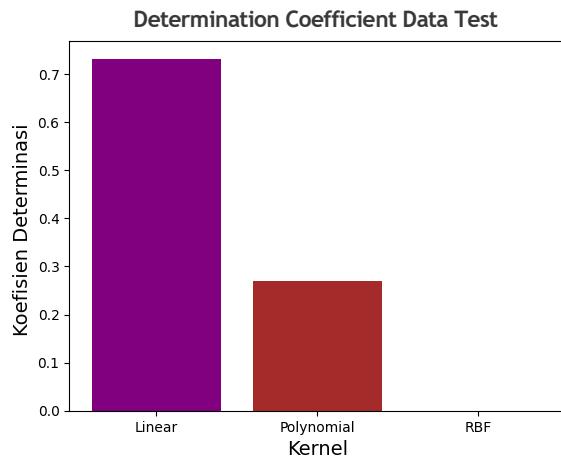


Figure 4. Comparison graph of Kernel data testing function

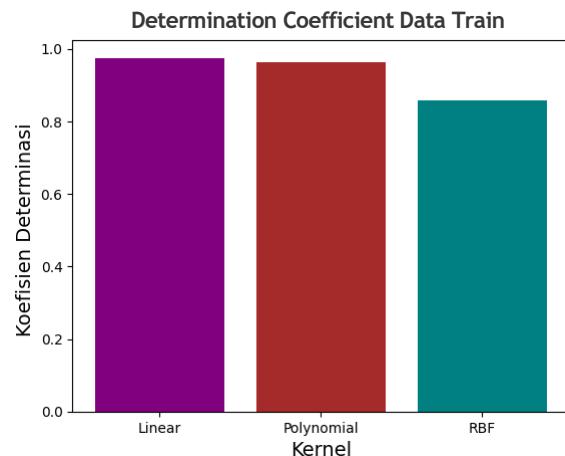


Figure 5. Comparison graph of Kernel data training function

polynomial kernel functions and RBF kernel functions. Verification using the best prediction model by looking at the three kernel functions' coefficients of determination (R^2). The use or function of the coefficient of the determination itself is to show the match of the estimated results of a regression model with the data modeled. In other words, the coefficient of determination (R^2) ensures the accuracy of the prediction model in regression analysis. In the R^2 calculation process, Python software is needed to calculate metrics from each Kernel function.

Based on Figure 4 and Figure 5, the coefficient of determination (R^2) value in each kernel function consists of two types, namely the value of the coefficient of determination of training data and the value of the coefficient of determination of testing data. From the two figures, it can be seen that in the training data, the most significant coefficient value falls on the linear kernel function, which is 0.975, while the value of the determination coefficient on the polynomial kernel function and the linear, radial base function kernel function is 0.964 and 0.858. Then, in the testing data, the most significant value of the coefficient of determination is also occupied by the linear kernel function, which is 0.732. At the same time, in the polynomial kernel function and the radial kernel function, the base function has values of 0.270 and -51.1. The value of the coefficient of determination in the training and test data shows that the linear kernel function has a better regression model accuracy for prediction than the other two functions. This is shown in the kernel radial base function, which has a negative coefficient of determination, which means that there is no influence of the model provided on the data presented [27].

Step 4: Ground Rod Sales Prediction

Using vector regression support and grid search algorithms, the best regression model is obtained, a linear kernel function model with $C = 100$ and $\varepsilon = 10^{-3}$. This model will then predict ground rod sales in the coming period. Before making predictions, this best model will show the results of the prediction graph both in the training and testing data, which will be shown in the visualization results in Figure 6 and Figure 7. The actual data and predictions that have been plotted show the slightest shift in predictions made by the model. This shows that the model can predict the ground rod sales level that will be used in the next period.

Table 7 shows the forecasting results of the selected regression model. Based on the table, sales or demand for ground rod products tend to increase, so XYZ Co. must prepare good production planning in order to meet customer demand. The recommendations for practitioners include using the linear kernel in similar demand forecasting applications to enhance accuracy and reduce costs.

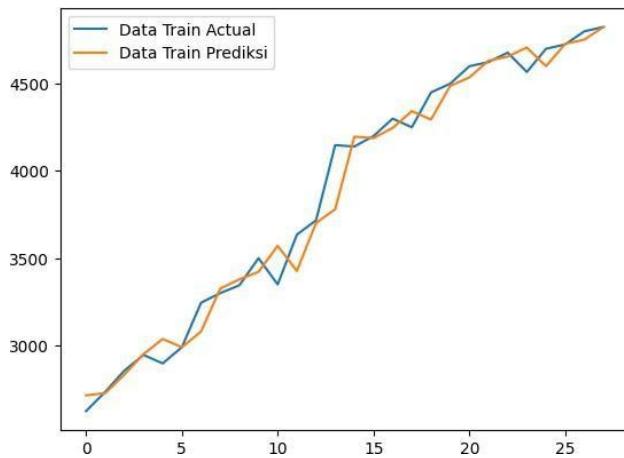


Figure 6. Graph of prediction data and actual data on training data training

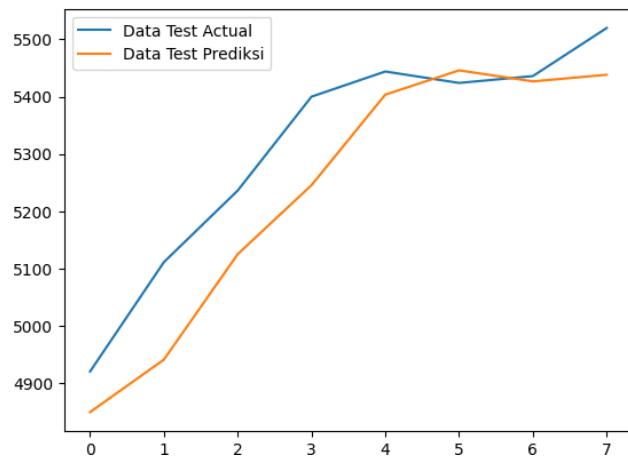


Figure 7. Graph of prediction data and actual data on training data testing

Table 7. Ground Rod Sales Prediction Results for the Next 5 Months

Month	Forecast
1	5697
2	6058
3	6593
4	7444
5	7444
Total	33.236

Step 5: Data visualization with Power BI

After getting the best model results, the overall data results at XYZ Co. can be displayed interactively and interestingly by visualizing Power BI. The goal is that in addition to summarizing the overall results, it can also display them in an integrated, clear, and exciting way to present. The data visualization this time will be displayed consisting of the following:

Sales by Product

Figure 8 explains that the ground rod products sold have several types, including ground rod products with a size of 1.5 meters (Ground Rod PK-AS 5/8 x 1500 mm), ground rods with a size of 2.4 meters (Ground Rod PK-AS 5/8 x 2400 mm), and ground rods with a size of 2.5 meters (Ground Rod PK-AS 5/8 x 2500 mm). The sales of these three types of ground rod products differ in the overall number sold in 2021 to 2023, for sales of ground rod products with a size of 1.5 meters (Ground Rod PK-AS 5/8 x 1500 mm) marked in purple has a sales contribution of 33,720 pieces or around 22.38% of the total sales. As for the sale of ground rods with a size of 2.4 meters (Ground Rod PK-AS 5/8 x 2400 mm) marked in blue has a sales contribution of 80,046 pieces, or around 52.73% of the total sales. Then, the sale of ground rods with a size of 2.5 meters (Ground Rod PK-AS 5/8 x 2500 mm) marked in pink has a sales contribution of 37,371 pieces or around 24.88% of the total sales. Thus, for the last three years, ground rod products with the most significant sales contribution are ground rod products with a size of 2.4 meters (Ground Rod PK-AS 5/8 x 2400 mm). In this dashboard, a filter feature is used both in years and months because this is useful so that companies can display directly what types of products can be seen within a certain period to conduct market analyses to increase profits and evaluation analysis for quality improvements for products that still have a small contribution.

Historical Graph of Ground Rod Product Sales

Figure 9 shows a graph depicting the overall sales of ground rod products from 2021 to 2023. For this dashboard, several features are used to see and monitor both for a predetermined month scale or year, which helps get information as needed in the timeline. This dashboard also shows the total results of all ground rod product sales in the last three years, which amounted to 148,228 pieces.

Ground Rod Product Sales/Demand Chart

Figure 10 shows a dashboard showing forecasting results using the linear kernel function's Support Vector Regression (SVR) method. As a result, in the next five months, demand for ground rod products tends to increase from January to May. For the total predicted demand for ground rod products in the next five months, 33,236 pieces were obtained.

Ground Rod Product Sales Dashboard Monitoring

Figure 11 describes the whole in terms of historical sales and forecasting later sales. In this dashboard, several features have been summarized from previous dashboards. These features consist of a time filter that can display sales from

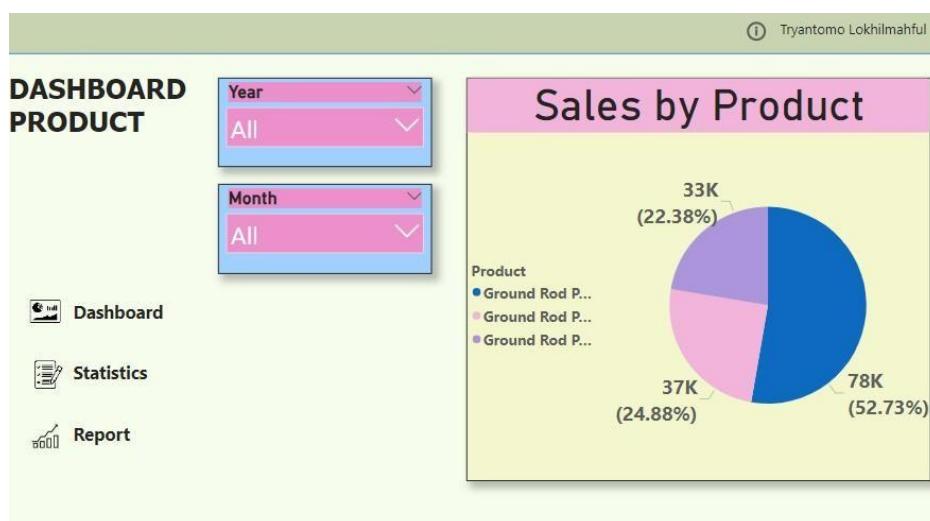


Figure 8. Dashboard product

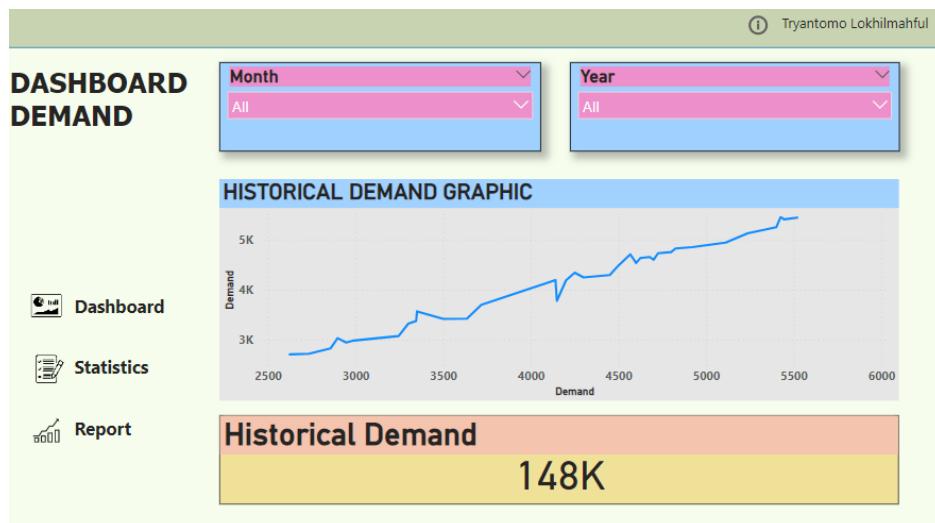


Figure 9. Dashboard demand

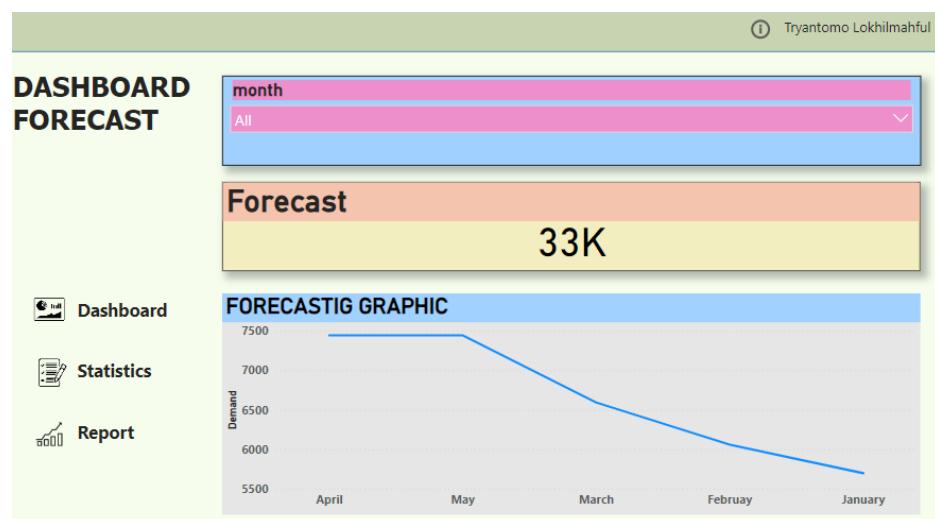


Fig 10. Forecast Dashboard

the cumulative side and the product type sold will appear according to a predetermined time. Then there is a pie chart that shows sales based on the type of product that has been sold, which can then be seen as the cumulative total by looking at the display of the "historical demand" feature according to the type of product chosen later. Furthermore, the last is an illustration in the form of a graph showing the track record of sales of ground rod products in the last three years, as well as forecasting of ground rod products in the next five months along with the cumulative total of the forecast.

CONCLUSION

The prediction model of the linear kernel and grid search algorithms is the most accurate model for XYZ Co.'s demand forecasting. The model optimizes parameters with MAPE values of training data and testing data. The proposed data visualization uses Power Business Intelligence software to display any data information. The data visualization proposal presented is a dashboard that produces several information presentations, including what has been created. There is a product dashboard that functions to recapitulate ground rod sales displayed based on the

type of product itself to see the highest contribution in getting the most significant profit. These results can benefit company production planning and inventory control processes by reducing costs, optimizing resource allocation, and enhancing overall efficiency.

ACKNOWLEDGMENT

We would like to express my sincere gratitude to the editor and the anonymous reviewers for their invaluable time, expertise, and constructive feedback. Their thoughtful comments and insightful suggestions significantly contributed to the improvement and refinement of this manuscript. I appreciate their commitment to maintaining the quality and rigor of the academic publication process.

CONFLICT OF INTEREST

The authors declare no conflicts of interest that could potentially compromise the objectivity, impartiality, or credibility of the research presented in this article.

FUNDING

The authors received no financial support for the research, authorship, and/or publication of this article.

References

- [1] S. Fattaheian-Dehkordi, A. Fereidunian, H. Gholami-Dehkordi, and H. Lesani, "Hour-ahead demand forecasting in smart grid using support vector regression (SVR)," *International Transactions on Electrical Energy Systems*, vol. 24, no. 12, pp. 1650–1663, Sep. 2013. doi: [10.1002/etep.1743](https://doi.org/10.1002/etep.1743).
- [2] E. Fradinata, Z. M. Kesuma, S. Rusdiana, and N. Zaman, "Forecast analysis of instant noodle demand using support vector regression (SVR)," *IOP Conference Series: Materials Science and Engineering*, vol. 506, p. 012021, Apr. 2019. doi: [10.1088/1757-899X/506/1/012021](https://doi.org/10.1088/1757-899X/506/1/012021).
- [3] R. A. Ramadhani, R. Fitriana, A. N. Habyba, and Y. C. Liang, "Enhancing quality control of packaging product: A Six Sigma and data mining approach," *J. Optimasi Sist. Ind.*, vol. 22, no. 2, pp. 197–214, 2023. doi: [10.25077/josi.v22.n2.p197-214.2023](https://doi.org/10.25077/josi.v22.n2.p197-214.2023).
- [4] M. Y. Latansa, T. J. Wahyu Adi, and M. A. Rohman, "Analysis the effect of total quality management, technology, and knowledge management on product quality in Indonesia construction industry," *IPTEK Journal of Proceedings Series*, vol. 0, no. 5, p. 527, 2019. doi: [10.12962/j23546026.y2019i5.8246](https://doi.org/10.12962/j23546026.y2019i5.8246).
- [5] C. Shoko and C. Sigauke, "Short-term forecasting of COVID-19 using support vector regression: An application using Zimbabwean data," *Am. J. Infect. Control*, vol. 51, no. 10, pp. 1095–1107, 2023. doi: [10.1016/j.jaic.2023.05.009](https://doi.org/10.1016/j.jaic.2023.05.009).
- [6] A. D. De Menezes, J. G. M. De Barros, B. B. Da Fonseca, M. V. C. Aguilera, and N. A. de S. Sampaio, "Demand forecasting and inventory management as requirements for quality assurance in a bakery company," *Rev. Gestão e Secr. (Management Adm. Prof. Rev.)*, vol. 14, no. 9, pp. 15680–15694, 2023. doi: [10.18577/gestao.v14n9.2023.1247](https://doi.org/10.18577/gestao.v14n9.2023.1247).
- [7] O. Duru and M. Butler, "Modeling and forecasting with fuzzy time series and artificial neural networks," *Adv. Bus. Manag. Forecast.*, vol. 12, pp. 155–180, 2017. doi: [10.1108/S1477-407020170000012006](https://doi.org/10.1108/S1477-407020170000012006).
- [8] S. K. Selvam, C. Rajendran, and G. Sankaralingam, "A linear programming-based bi-objective optimization for forecasting short univariate time series," *Decis. Anal. J.*, vol. 10, p. 100400, 2024. doi: [10.1016/j.dajour.2023.100400](https://doi.org/10.1016/j.dajour.2023.100400).

[9] V. M. Evangelista and R. G. Regis, "Exploring the suitability of support vector regression and radial basis function approximation to forecast sales of Fortune 500 companies," *Adv. Bus. Manag. Forecast.*, vol. 13, pp. 3–23, 2019. doi: [10.1108/S1477-407020190000013006](https://doi.org/10.1108/S1477-407020190000013006).

[10] D. Indra Purnama and S. Setianingsih, "Model support vector regression (SVR) untuk peramalan jumlah penumpang penerbangan domestik di Bandara Sultan Hasanudin Makassar," *J. Mat. Stat. dan Komputasi*, vol. 16, no. 3, pp. 391–403, 2020. doi: [10.20956/jmsk.v](https://doi.org/10.20956/jmsk.v).

[11] S. Maldonado, A. González, and S. Crone, "Automatic time series analysis for electric load forecasting via support vector regression," *Appl. Soft Comput. J.*, vol. 83, p. 105616, 2019. doi: [10.1016/j.asoc.2019.105616](https://doi.org/10.1016/j.asoc.2019.105616).

[12] D. Parbat and M. Chakraborty, "A python-based support vector regression model for prediction of COVID-19 cases in India," *Chaos, Solitons and Fractals*, vol. 138, p. 109942, 2020. doi: [10.1016/j.chaos.2020.109942](https://doi.org/10.1016/j.chaos.2020.109942).

[13] H. Niu, "A method to increase the analysis accuracy of stock market valuation: A case study of the Nasdaq Index," *Int. J. Adv. Comput. Sci. Appl.*, vol. 15, no. 1, pp. 732–743, 2024. doi: [10.14569/IJACSA.2024.0150173](https://doi.org/10.14569/IJACSA.2024.0150173).

[14] T. Papadimitriou, P. Gogas, and V. Plakandaras, "Testing exchange rate models in a small open economy: An SVR approach," *Bull. Appl. Econ.*, vol. 3, no. 2, pp. 9–29, 2016.

[15] A. Irankhah, M. H. Yaghmaee, and S. Ershadi-Nasab, "Optimized short-term load forecasting in residential buildings based on deep learning methods for different time horizons," *J. Build. Eng.*, vol. 84, p. 108505, 2024. doi: [10.1016/j.jobe.2024.108505](https://doi.org/10.1016/j.jobe.2024.108505).

[16] B. H. Prakoso, "Implementasi support vector regression pada prediksi inflasi indeks harga konsumen," *MATRIX J. Manajemen, Tek. Inform. dan Rekayasa Komput.*, vol. 19, no. 1, pp. 155–162, 2019. doi: [10.30812/matrik.v19i1.511](https://doi.org/10.30812/matrik.v19i1.511).

[17] M. Ryu and K. Lee, "Selection of support vector candidates using relative support distance for sustainability in large-scale support vector machines," *Appl. Sci.*, vol. 10, no. 19, pp. 1–14, 2020. doi: [10.3390/app10196979](https://doi.org/10.3390/app10196979).

[18] R. Zhang, Y. Li, Y. Gui, D. J. Armaghani, and M. Yari, "A stacked multiple kernel support vector machine for blast induced flyrock prediction," *Geohazard Mech.*, Jan. 2024. doi: [10.1016/j.ghm.2024.01.002](https://doi.org/10.1016/j.ghm.2024.01.002).

[19] B. M. Henrique, V. A. Sobreiro, and H. Kimura, "Stock price prediction using support vector regression on daily and up to the minute prices," *J. Financ. Data Sci.*, vol. 4, no. 3, pp. 183–201, 2018. doi: [10.1016/j.jfds.2018.04.003](https://doi.org/10.1016/j.jfds.2018.04.003)

[20] E. S. Hedianti, "Peramalan harga saham dengan menggunakan metode support vector regression (SVR)," unpublished, 2019.

[21] D. Sepri and A. Fauzi, "Prediksi harga cabai merah menggunakan support vector regression," *CBIS Journal*, vol. 8, no. 2, pp. 1–5, 2020.

[22] M. Awad and R. Khanna, *Efficient Learning Machines: Theories, Concepts, and Applications for Engineers and System Designers*. Springer, 2015. [Online]. Available: <https://link.springer.com/book/10.1007/978-1-4302-5990-9>.

[23] G. Astudillo, R. Carrasco, C. Fernández-Campusano, and M. Chacón, "Copper price prediction using support vector regression technique," *Appl. Sci.*, vol. 10, no. 19, pp. 1–13, 2020. doi: [10.3390/APP10196648](https://doi.org/10.3390/APP10196648).

[24] R. Babagoli and M. Rezaei, "Prediction of moisture resistance of asphalt mastics modified by liquid anti-stripping based on support vector regression, artificial neural network and kernel-based support vector regression methods," *Constr. Build. Mater.*, vol. 335, no. March, p. 127480, 2022. doi: [10.1016/j.conbuildmat.2022.127480](https://doi.org/10.1016/j.conbuildmat.2022.127480).

[25] A. Hermawan, I. W. Mangku, N. K. K. Ardana, and H. Sumarno, "Analisis support vector regression dengan algoritma grid search untuk memprediksi harga saham," *J. Math. Its Appl.*, vol. 18, no. 1, pp. 41–60, 2022. doi: [10.29244/milang.18.1.41-60](https://doi.org/10.29244/milang.18.1.41-60).

[26] S. Xie, H. Lin, Y. Chen, H. Duan, H. Liu, and B. Liu, "Prediction of shear strength of rock fractures using support vector regression and grid search optimization," *Mater. Today Commun.*, vol. 36, no. May, p. 106780, 2023. doi: [10.1016/j.mtcomm.2023.106780](https://doi.org/10.1016/j.mtcomm.2023.106780).

[27] W. Yi, I. V. Gerasimov, S. A. Kuzmin, and H. He, "An intelligent algorithm of support vector regression parameters optimization in soft measurements," *Proc. 19th Int. Conf. Soft Comput. Meas. SCM 2016*, no. 1, pp. 404–406, 2016. doi: [10.1109/SCM.2016.7519794](https://doi.org/10.1109/SCM.2016.7519794).

[28] R. E. Caraka, H. Yasin, and A. W. Basyiruddin, "Peramalan crude palm oil (CPO) menggunakan support vector regression kernel radial basis," *J. Mat.*, vol. 7, no. 1, p. 43, 2017. doi: [10.24843/jmat.2017.v07.i01.p81](https://doi.org/10.24843/jmat.2017.v07.i01.p81).

[29] D. Chicco, M. J. Warrens, and G. Jurman, "The coefficient of determination R-squared is more informative than SMAPE, MAE, MAPE, MSE and RMSE in regression analysis evaluation," *PeerJ Comput. Sci.*, vol. 7, pp. 1–24, 2021. doi: [10.7717/PEERJ-CS.623](https://doi.org/10.7717/PEERJ-CS.623).

[30] R. Fitriana, D. Sugiarto, M. K. Hidayat, and Y. E. H. Turnip, "Perancangan model sistem intelijensia bisnis," *Wawasan Ilmu*, 2024.

[31] K. V. Metre, A. Mathur, R. P. Dahake, Y. Bhapkar, J. Ghadge, P. Jain, and S. Gore, "An introduction to Power BI for data analysis," *Int. J. Intell. Syst. Appl. Eng.*, vol. 12, no. 1s, pp. 142–147, 2023.

[32] R. Fitriana, J. Saragih, and N. Luthfiana, "Model business intelligence system design of quality products by using data mining in R Bakery Company," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 277, no. 1, 2017. doi: [10.1088/1757-899X/277/1/012005](https://doi.org/10.1088/1757-899X/277/1/012005).

[33] S. Widjaja and T. Mauritsius, "The development of performance dashboard visualization with Power BI as platform," *Int. J. Mech. Eng. Technol.*, vol. 10, no. 5, pp. 235–249, 2019. [Online]. Available: <http://www.iaeme.com/IJMET/issues.asp?JType=IJMET&VType=10&IType=5>.

[34] R. Adinugroho, *Perbandingan rasio split data training dan data testing menggunakan metode LSTM dalam memprediksi harga indeks saham Asia*. 2022. [Online]. Available: <https://repository.uinjkt.ac.id/dspace/handle/123456789/67314>.

[35] A. N. Safira, B. Warsito, and A. Rusgiyono, "Analisis support vector regression (SVR) dengan algoritma grid search time series cross validation untuk prediksi jumlah kasus terkonfirmasi COVID-19 di Indonesia," *J. Gaussian*, vol. 11, no. 4, pp. 512–521, 2023. doi: [10.14710/j.gauss.11.4.512-521](https://doi.org/10.14710/j.gauss.11.4.512-521).

[36] F. Kaliyadan and V. Kulkarni, "Types of variables, descriptive statistics, and sample size," *Indian Dermatol. Online J.*, vol. 10, no. 4, pp. 481–485, 2017. doi: [10.4103/idoj.IDOJ](https://doi.org/10.4103/idoj.IDOJ).

[37] Y. Dong, "Descriptive statistics and its applications," *Highlights Sci. Eng. Technol.*, vol. 47, pp. 16–23, 2023. doi: [10.54097/hset.v47i.8159](https://doi.org/10.54097/hset.v47i.8159).

[38] A. Zakrani, A. Najm, and A. Marzak, "Support vector regression based on grid-search method for agile software effort prediction," *Colloq. Inf. Sci. Technol. CIST*, vol. 2018-Octob, pp. 492–497, 2018. doi: [10.1109/CIST.2018.8596370](https://doi.org/10.1109/CIST.2018.8596370).

[39] A. W. Ishlah, S. Sudarno, and P. Kartikasari, "Implementasi gridSearchCV pada support vector regression (SVR) untuk peramalan harga saham," *J. Gaussian*, vol. 12, no. 2, pp. 276–286, 2023. doi: [10.14710/j.gauss.12.2.276-286](https://doi.org/10.14710/j.gauss.12.2.276-286).

AUTHORS BIOGRAPHY

Tryantomo Lokhilmahful Palgunadi is an Industrial Engineering graduate from Universitas Trisakti, Jakarta. He obtained his Bachelor degree in the Department of Industrial Engineering, Faculty of Industrial Technology, Universitas Trisakti Jakarta, in 2024. He was a lecturer assistant at the Quality Engineering Laboratory.

Rina Fitriana is an Associate professor and Head of Department in the Department of Industrial Engineering, Universitas Trisakti, Indonesia. Her educational background includes a Bachelor of Industrial Engineering from

Universitas Trisakti, a Magister of Management from PPM School of Management, and a Doctor of Agricultural Industry Technology from IPB University. She has many researchs in Industrial Engineering. Her research interests include Quality Engineering, Analyze System analysis of information system design, Data Mining, and Business Intelligence. Rina can be contacted at email: rinaf@trisakti.ac.id

Anik Nur Habyba is a lecturer and Head of the Quality Engineering Laboratory in the Department of Industrial Engineering, Universitas Trisakti, Indonesia. Her educational background is a Bachelor of Agricultural Industry Technology from Brawijaya University and a Master of Agricultural Industry Technology from IPB University. She has more than five years of teaching/ research in Industrial Engineering. Her research interests include Statistics, Quality Engineering, Design of Experiments, and Technology-based entrepreneurship. Anik can be contacted at email: anik@trisakti.ac.id

Yun-Chia Liang is a Professor and Chair of the Department of Industrial Engineering & Management, Yuan-Ze University, Taiwan, ROC. His Research & Interests are Meta-Heuristics, Intelligent Computing, Production Scheduling, Logistics Management, and Artificial Neural Network Applications.