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Table of Contents

Title Page 1 i

Title Page 2 ii

Copyright Notice iii

Table of Contents iv

Preface xv

Organizer & Committees xvi

Keynotes Speech 1 xviii

Keynotes Speech 2 xix

Keynotes Speech 3 xx

Econometric Insights Through Eviews: Decoding The Macroeconomic Factors in Shaping ASEAN-6 Exchange Rates Using Software Technology Application 1

Raka Agfial, Adiska Sanfa and Benny Tjandrasa

Trajectory Analysis of Inter-Island Logistics Transportation for Aggregate Material Using Web-Based Information 7

Aji Suraji, Syarifuddin Ishak, Prabowo Prabowo, Muhammad Fatkhurrozi, Gholiqul Amrodh Alawy and Rangga Pahlevi Putra

Literature Study: Intelligent Character Recognition (ICR) Technology for Learning Innovation 12

Sunaryo Winardi, Gunawan, Frederic Davidsen, Farrell Rio Fa and Frans Mikael Sinaga

Plagiarism on Mobile Programming Assessments: Automated Detection 18

Oscar Karnalim, Erico Darmawan Handoyo, Meliana Christianti Johan and Daniel Jahja Surjawan

The Use of Markerless Augmented Reality Flash Card for English Vocabulary Building 23

Sulaeman Santoso and Daniel Jahja Surjawan

Utilization of K-Means Clustering to Examine Library User Segmentation's Impact on Student Graduation Rates 28

Ihdi Ritonga, Ade Candra and Mohammad Andri Budiman

Systematic Literature Review: On Measuring the Level of Emotional Experience Based on EEG Signals 34

Yudo Devianto, Adi Setiawan, Christine Dewi, Ade Iriani, Hindriyanto Purnomo and Irwan Sembiring

Examining The Effect Of Financial Literacy Variables In UTAUT2 Model On The Use Of E-wallet 39

Bobby Garcia Tanura and Erwin Setiawan Panjaitan

Analysis of Closing Stock Price Predictions Energy Sector in Indonesia Using Convolutional Neural Network 45
Jennifer Utomo, Angeline Putri Wijaya, Kenji Nicholas Adinata, Karin Natania Huang, Helena Margaretha and Ferry Ferdinand

Deep Learning-Based Web Application for Flower Recognition and Status Monitoring 51
Theophilus Chidalu Onyejiaku, Cosmas Ifeanyi Nwakanma and Bernard Chukwuemeka Ekeoma

Comparison of Operations in Fuzzy Approximate Reasoning and Centroid of Membership Function 57
Takashi Mitsuishi

Enhancing Warehouse Inventory Management through IoT Tools for Monitoring Stock Items 62
Sunaryo Winardi, Apriyanto Halim, Sunario Megawan, Poi Wong Ng and Arifin

Modeling Plagiarism Prevention in Scientific Publication Using Enhanced Blockchain 68
Poi Wong Ng, Carles Juliandy and Darwin Darwin

Usability Evaluation of Microsoft Teams Applications for Higher Education 76
Murdiaty Murdiaty, Handoko Handoko and Joosten Joosten

GoEliTool Usability Level Evaluation 82
Joko Purwadi and Rosa Delima

Enhancement of Indonesian Language Learning Motivation Using Trivia Game..... 88
Louis Khrisna Putera Suryapranata and Giovanni Ivander Gozali

Bitcoin Cryptocurrency Price Prediction Using IFA-BiLSTM..... 94
Andre Pratama

Deep Learning Approach for Stunting Classification in Toddlers 100
Wulan Sri Lestari, Caroline Caroline and Yuni Marlina Saragih

On Block Lattice Architecture Platform, an Extraordinary of Lattice Cryptography 105
Loso Judijanto, Dwi Liestyowati, andiyan andiyan, Iin Arianti, Galih Ariprawira and Mohamad Aghust Kurniawan

Imputation Missing Stock Prices using Generative Adversarial Networks and Attention Mechanism..... 113
Agus Tri Haryono, Riyanarto Sarno, Ratih Nur Esti Anggraini and Kelly Rossa Sungkono

Unlocking Nutritional Insights: Exploring Meal Analysis for Enhanced Dietary Choices with Multinomial Logistic Regression..... 119
Yohanssen Pratama and Tegar Prasetyo

Deep Learning for Predicting Food Commodity Prices in Traditional Markets 125
Fajar Kamaludin Akhmad, Sudianto Sudianto and Dasril Aldo

User Experience Design of Mobile Application for Tuberculosis Care and Prevention in Indonesia 131
Felix

Business Closure Prediction Based on Users Rating and Review Using H2O 136
Enjelin Enjelin, Ronsen Purba and Muhammad Fermi Pasha

Can Pixel-based Approach Achieve Similar Performance to Area-based Approach in Crop Yield Forecasting using Sentinel-2 Imagery and Deep Neural Networks? A Probabilistic Analysis 142
Khadija Meghraoui, Imane Sebari, Saloua Bensiali and Kenza Ait El Kadi

Dangerous Objects Detection and Segmentation in X-ray Images of Passenger Goods using YOLOV8 148

Timothy Kristanto and Evan Tanuwijaya

System Design for Therapist Retention Analysis in an Online Mental Healthcare Application Based on MapReduce 154

Iwan Santosa, Panji Yudasetya Wiwaha, Hapnes Toba, Andreas Widjaja, Giezka Veby Agustin and Katrine Katrine

A Novel Activity Recommendation System of Financial Balance Scorecard for COBIT 2019 Based on Company Strategy 160

Lukman Sanjani, Ulima Shabrina, William Phedra, Riyanarto Sarno and Kelly Sungkono

Transformative Human Resources: Mapping Future Directions for Innovation in Information Technology and Multidisciplinary Applications 166

Natalia Noya and Marcellia Susan

Comparative Study of Statistical, Machine Learning, and Deep Learning for Rice Retail Price Forecasting in West Java 172

I Nyoman Gde Mahaputra Wardhiana, Muhammad Ghufron, Riyanarto Sarno, Agus Haryono, Shoffi Izza Sabilla, Fadilatul Taufany, Sholiq . and Kelly Sungkono

A Comparative Analysis of Macroeconomic Indicators in Optimising Credit Risk Prediction 178

Evelyn Sierra, Erick Delenia, Eric Lays, Riyanarto Sarno and Agus Haryono

Multi-class Oil Palm Trees Condition Detection from UAV Images using Faster R-CNN with EfficientNetV2 184

Arinal Haq, Eko Sugeng Cahyadi, Muhammad Shafhi Kasyfillah, Riyanarto Sarno and Agus Haryono

Process Mining For Evaluating Hospital Billing System Based On DSS01 Domain COBIT 2019 Framework 190

Muhammad Yusuf, Arinal Haq, I Nyoman Gde Mahaputra Wardhiana, Riyanarto Sarno and Kelly Sungkono

Integrating Class Imbalance Solutions into Fraud Detection Systems: A Systematic Literature Review . 196

Wowon Priatna, Hindriyanto Purnomo, Irwan Sembiring and Theophilus Wellem

Identifying Non-Conforming Process in Automobile Insurance Claims using Process Mining and COBIT 2019 202

Rizqy Ahsana Putri, Lauretha Fajar Vantie, Kelly Sungkono and Riyanarto Sarno

A Recommendation System for Internal Business Processes of COBIT 2019 Using Graph Algorithm and Similarity Methods 208

I Gusti Lanang Agung Oka Cahyadi Pradipta, Rizky Damara Ardy, Riyanarto Sarno and Kelly Sungkono

Automated Extraction of Microservice Architecture Using a Rule-Based Approach 214

Rizqy Ahsana Putri, Muhammad Nevin, Dwinanda Bagoes Ansori, Abdullah Faqih Septiyanto and Riyanarto Sarno

Modeling Indonesian Thesaurus on Simple Knowledge Organization System 220

Budi Susanto, Michael Himawan Handoko and Gloria Virginia

A Deep Learning Approach for Word Segmentation in Javanese Letter Manuscript Transliteration 226

Muhammad Nevin, I Kadek Agus Ariesta Putra, Dwinanda Bagoes Ansori, Riyanarto Sarno and Agus Haryono

Transforming Digital Identity through Smart Contract as Identity 232

Yustus Eko Oktian, Kei Patrick Hilton and Christian

Enhancing Agricultural Pesticide Application through a Custom-Built Hexacopter Equipped with Advanced Control and Navigation Systems 238

Albert Sagala, Petrus Sinaga, Irfan Manik and Sandro Siagian

Gamification Design for Temple Tourism Application 244

Yurri Wagiu, Andi Emanuel and Pranowo Pranowo

Utilization of GC-MS in Determination of Electronic Nose Sensor Array for Classification of Gambung Green Tea Quality 249

Rini Handayani, Riyanarto Sarno, Dedy Rahman Wijaya, Kelly Sungkono and Daniel Yeri Kristiyanto

Enhancing Organizational Performance Through Strategic Knowledge Sharing: Insights and Models ... 255

Nathania M. Lisandi, Riswan E. Tarigan, Calandra A. Haryani, Hery and Andree E. Widjaja

A Multi-Perspective Process Explorer Method to Identify Anomaly of An Education ERP 261

I Made Murwantara and Kristina Wulandari

Data-Driven Exploration: Analyzing Triage Data's Role in Predicting Intensive Care Unit Transfers within 24 Hours 267

Andrian Crispin, Muhammad Atqa Adzkia Zaldi, Victor Hulu and Abdi Dharma

Enhancing Endless Runner Gameplay: Integrating Brainwave-Based Natural Interaction with Rule-Based Management System 272

Matahari Bhakti Nendya, Lailatul Husniah, Hardianto Wibowo, Syahri Mu'min and I Kadek Dendy Senapartha

Improving SVM Performance in Determining Cost and Kernel Parameter Values through Grid Search 277

Visca Sylvia, Maya Silvi Lydia and Benny Benyamin Nasution

Performance Improvement Of Support Vector Machine With Firefly Algorithm For Public Complaints Classification 283

Alfi Rahman, Elviawaty Zamzami and Sawaluddin Sawaluddin

A Novel Deep Learning-Based Multi-Model Ensemble Approach for the Prediction of Non-Small Cell Lung Cancer (NSCLC) Metastasis via Integration of Multi-omics Data 288

Akshay Karthik and Michael Donovan

Word Segmentation Task for Southeast Asian Abugida Scripts: A Systematic Literature Review 294

Baskoro Adi Wicaksono, Bimo Sunarfri Hantono and Teguh Bharata Adji

Optimizing IT Governance and Project Management in Software Development through AI Integration and COBIT 2019 Framework 300

Andy Teguh, Joko Slamet, Hartono Saputro, Kelly Sungkono and Riyanarto Sarno

Twitter Data Extraction for Food and Beverage Business Analytics 306

Muhammad Atqa Adzkia Zaldi, Opim Salim Sitompul, Erna Budhiarti Nababan and Andrian Crispin

Data Preprocessing on Triage Data for Predicting ICU Transfer within 24 Hours 312

Andrian Crispin, Ade Candra and Opim Salim Sitompul

Tourist Route Recommender System Using Whale Optimization Algorithm (A Case Study of Yogyakarta) 318

Vivi Fitriani and Z. K. A. Baizal

Analysis of AI's Impact on Purchase Intention on Social Media Platforms 324

Cristanto Sidharta, Nathaniel Ardyana Putra, Jonathan Chandra and Marisa Karsen

Identifying Suspicious Financial Transaction Using Machine Learning and Phytagorean Tree 330

I Made Murwantara and Pricilia Fiesta Griece Prasethio

Safety Helmet Detection Based on YOLOv7 With Super-Resolution Reconstruction 336
Justin Yap and Trianggoro Wiradinata
Unlocking Customer Loyalty: A Study of User Experience in Tokopedia 342
Naomi Natania Magdalena, Elfindah Princes and Desman Hidayat
Architecting Multisite Database Proxy using ProxySQL 348
Jefri Abdurrozak Ismail
A Study of The Implementation of Paylater Feature for Customer Satisfaction Using the Servqual Method in Marketplace Applications in Indonesia 354
Hery Hery, Andree Widjaja, Calandra Haryani and Riswan Tarigan
The Role of Data Visualization in Improving the Sustainability of Smallholdings 359
Ahmad Maulana, Ade Candra and Amalia Amalia
Machine Learning-based Application for Predicting Hearth Disease Risk using CreateML 364
Theresia Ratih Dewi Saputri and Edwin Kurniawan
Exploring Ethical Implications: Unraveling Factors Influencing Data Governance Awareness Behavior in Generative AI Chatbot 369
Roger Amendi, Erwin Halim and Hendry Hartono
Chatbot for Complex Questions in University Admission using Bidirectional Long-Short Term Memory and Convolutional Neural Network 375
Djoni Setiabudi, Gregorius Budhi and Alfons Sampurno
Enhancing High School Students Admission Process Through Web-Based Information System 380
Michael Chandra and Stephanus Eko Wahyudi
Secured e-Voting System Leveraging Blockchain Technology 385
Elizabeth Witanto
GIS-based Disaster Preparedness and Mitigation Applications: A Systematic Review on Methods, Features, and Visualization 391
Aditya Bimo Pitandoyo, Lukito Edi Nugroho and Bimo Sunarfri Hantono
Techniques for Handling Missing Values in Customers Electricity Data: A Systematic Literature Review 398
Mahda Dina Alam Rusbandi, Silmi Fauziati and Guntur Dharma Putra
UX Law Implementation at Sevima edLink from Design Science Research Perspective 404
Indri Rozas and Aris Tjahyanto
IoT Gateway Design for Real Time QR-Code Display Device in Security Monitoring System 410
Laurentius Kuncoro Probo Saputra, Restyandito Restyandito, Willy Sudiarto Raharjo, Anthonius Adi Nugroho, Samuel Ricky Saputro and Bryan Rama Putra
Design and Development of a Guitar Learning Mobile Web for the Music Department of Rose of Sharon Church 416
Nico Prasetyo and Kartika Gianina Tileng
Design and Development a Web-Based System for Recording Transactions of Contracted Service for Industrial Machine Repair at CV. Elmectro Mandiri 421
Pravangasta Wahyudi and Rinabi Tanamal
Analyzing The Effect of Ease of Use towards Continous Use Intention and Satisfaction on E- Government Services in Indonesia 426
Erwin Halim, Decwind Susanto, Annisa Zahri and Willy Candra
Analysis of Customer Satisfaction of Using Kios-K Machine in Fast Food Services: Case of Indonesian. 432

Erwin Halim, Michael Jonathan, Archibald Matthew Kribiantoro and Christian Johanes

American Sign Language to Text Translation using Transformer and Seq2Seq with LSTM 438
Gregorius Guntur Sunardi Putra, Adifa Widyadhani Chanda D'Layla, Dimas Wahono, Riyanarto Sarno and Agus Haryono

Evaluating the Efficacy of Sentinel-2B and Landsat 8 OLI Satellite Imagery for Accurate Mangrove Mapping in Bengkulu City, Indonesia 444
Ayub Sugara, C C Hanami, A H Lukman, Aninda W Rudiastuti, Zamdial Zamdial, Deddy Bakhtiar, Ari Anggoro, R Zulhendri and R T Utami

Consumer Trust and Brand Reputation: Driving Mechanical Keyboard Purchase Intention on Instagram 450
Hanif Akbar Ramadhan, Elfindah Princes and Desman Hidayat

Connected Automated Vehicles Entry Capacity on Roundabouts- Case Study Hungary 455
Haitham Al Hasanat, Omar Alharasees and Dania Alothman

Public Perception of Autonomous and Shared Autonomous Vehicles: Case Study of Amman 461
Omar Alharasees, Haitham Al Hasanat and Dania Alothman

Long Short-Term Memory (LSTM) Improvement Accuracy Using FastText and Glove for Language Translation Batak – Indonesian 466
Atikah Rahayu Mandasari, Erna Budhiarti Nababan and Herman Mawengkang

The Influence Of Sales Promotion, Attractiveness of Internet Advertising, and App Quality Features on Impulse Buying Decisions for Batik Fashion Products At Tiktok Shop 471
Fadilla Kardika Putri , Mochammad Rizki Pratama, Muhammad Raihan Rafi Al Azharr, Yuniarty Yuniarty and Ferry Hartono

Minimally Invasive Motor Function Rehabilitation through Digital Twin Technology: A Review 477
Brain Harlan and Hendra Tjahyadi

Analysis of public views of the motor vehicle financing services information system 482
Ikrar Arin, Bryan Bryan and James Wibawa

Analysis of the impact of ChatGPT utilization on the levels of laziness and productivity 488
Ikrar Arin, Arsyil Farkhan, fahmi muhamad and Fairuz Thahirah Anjani

Comparison of Clustering Results using K-Means, Gaussian Mixture Models, Based on Seven Sectors of Country Electricity and Correlation with Gross National Income 495
Samuel Lukas, Regina Maureen Suryaputri and Petrus Widjaja

Assembly Line Balancing Optimization using Genetic Algorithm Method Compared to Heuristic Method 499
Christopher Nata, Nathaniel Frederick and Priskila Rahayu

Detection of Cyberbullying Incidents on the X Social Network 505
Azka Elhan, Deo Chuanito, Henry Lucky and Derwin Suhartono

Application of Used Car Price Predictor in Indonesia along with Machine Learning Model Comparison and SMOTE 511
Rafael Wibowo, Alvino Vallian, Henry Lucky and Derwin Suhartono

Performance Analysis of Regression Models on Predicting Movie Ratings 516
Ignatius Kennard, Hansel Hartono, Henry Lucky and Derwin Suhartono

The Influence of Automotive Brand Awareness on Purchase Interest through Social Media Usage of TikTok Case Analytics 522

Farabi Alghifari and Rido Sarwono

Brute Force Algorithms for Job Shop Scheduling Problem 528
Samuel Lukas and Aditya Mitra

Reveal the Power of E-Filing and Transform Tax Reporting in Indonesia : using UMEGA analysis..... 533
Levana Dhia Prawati, Mahda Karina, Graciella Cherrysca Addy Putri and Ismi Fathia Rachmi

Movie Success Prediction Using Machine Learning Models 539
Michael Kristianto, Deastri Anggie Shanovera, Janette Mirna Putri Trijono, Ivan Sebastian Edbert and Derwin Suhartono

Fake Job Vacancy Detection Using Ensemble Voting Classifier..... 545
Torian Ariel Yaphet, Made Adhiaksena Wikrama Putra, Vicensia Charitas Avianny, Ivan Sebastian Edbert and Derwin Suhartono

The Mediating Effect of Digital Payment Tools in the Relationship Between Digitalization and Use of Technology to Increase Sales on MSMEs 552
Danang Prihandoko, M Hamsal, Arta Sundjaja and Willy Gunadi

Region-Based People Counting with Embedded System in Smart Building Environment..... 558
Raden Mas Benediktus Suryo Wicaksono, I Wayan Mustika and Selo Sulistyo

Comparing AI and Expert Opinion for Detecting Technological Trends in Indonesia's Transportation and Storage Industry 564
Nopriadi Saputra, Thedy Karuna Ernesto, Salma Indah Pangesti Pangesti, Natalia Natalia, Faustina Nethania and Elrika Indra

The Road to Digitalization : Exploring the Impact of Using Digital Payments and Marketing on Business Sustainability in MSMEs..... 569
Wahyu Setyobudi and Raja Dava

Systematic Literature Review: Disease Classification Modeling Using Deep Learning Algorithms 575
Wawan Gunawan, Hindriyanto Purnomo, Christine Dewi, Ade Iriani and Irwan Sembiring

Customer Segmentation Using Generated Coffee Export Transaction Data 581
Syarifah Chaira Zulfa, Erna Budhiarti Nababan and Mohammad Andri Budiman

Stock Price Prediction on LQ45's Banking Sector Using Long-Short-Term Memory and Convolutional Neural Network 587
Shannen Surya Wibisono, Karissa Leviana, Timothy Sean Muliadiredja, Helena Margaretha, Ferry Ferdinand and Jennifer Utomo

Streamlining Meatball Manufacturing: Lean Principles and Efficiency Improvements 592
Anthony Matthew and Laurence

Innovative Climate Solutions: Simulating the Future with En-ROADS 598
Christopher Alfredo, Laurence and Agustina Christiani

Gender Classification Based on Fingerprint Using Sobel Filter and Artificial Neural Network 603
Sri Suwarno and Lukas Chrisantyo

Exploring The Impact of Social Media Adoption to Small Medium Enterprises (SMEs) Performance 608
Erwin Halim, Pandu Darmawan, Sudiana Sudiana, Yuliana Lisanti , Liana Sugandi and Placide Poba-Nzaou

Exploring the Nexus of Website Security and Design for Superior Service Quality, Customer Satisfaction, and Loyalty 614
Erwin Halim, Decwind Susanto, Sudiana Sudiana, Yuliana Lisanti, Jessicania Windari and Ai Ping

Teoh

Actor and Network Analysis: The Existence of Virtual Public Sphere on YouTube 620
Frederik Gasa, Sidharta Sidharta, Bhekti Setyowibowo, Yongkie Angkawijaya, Adellya Triagustin and Norfarizah Bakhir

Study on Object-Relational Mapping (ORM) Data Model Performance Effects in the Oil and Gas Industry 626
Darren Mannuela Pangesa, Maria Seraphina Astriani and Ida Manuaba

The Relationship between Social Media Marketing, Product Innovation, and Brand Equity with Mediated Customer Engagement in the Indonesian Packaged Tea Industry 632
Indra Raharja, Sarah Qonitah and Dicky Syahchari

Comprehensive Monitoring of Asthma: Evaluating Vital Signs, Sleep Quality, Air Quality, and Psychological Factors 638
David Hareva and Sherly Nathasya

Exploring Penetration Testing: A Comparative Analysis of Brute Force Directory Tools in Vulnerability Analysis Phase 644
Naufal Seira Muhammad Farras, Jason Loderick, Hanis Amalia Saputri and Azani Cempaka Sari

Node-Based Mapping for Augmented Reality Indoor Navigation 650
Felix Nathanael Tjahjono, Matahari Bhakti Nendya, I Kadek Dendy Senapartha, Tasya Setyo Harwati and Kenny Ivander Jovan

Usability Evaluation Of Augmented Reality Indoor Navigation : A System Usability Scale Approach 655
Tasya Setyo Harwati, Matahari Bhakti Nendya, I Kadek Dendy Senapartha, Yuan Lukito, Felix Nathanael Tjahjono and Kenny Ivander Jovan

Automatic Question-Answer Generation for Education on Indonesian Texts : A Review of Methodologies, Dataset and Evaluation Metrics 660
St Tuhpatussania, Ema Utami, Kusrini Kusrini and Kumara Ari Yuana

Feature Extraction Techniques for Patterned Images: A Systematic Literature Review 666
Wenti Wahyuni, Arief Setyanto, Ema Utami and Kusrini Kusrini

Enhancing Heart Rate Detection Accuracy Through the Kalman Filter Algorithm 672
Mangasa A. S. Manullang, Poltak Sihombing and Mahyuddin K. M. Nasution

Digital Marketing Benchmark Between Cafes in Asean: A Systematic Literature Review 678
Daffa Prakoso Hadi and Rido Sarwono

An Adaptive Electric Field Stereotaxis Method for Brain Surgical Navigation 684
Yuxin Fang, Fan Yang, Wei He, Pengbo Wang, Zhenyou Liu and Wei Zhang

Customer Segmentation Based on Recency, Frequency, Monetary, Variety and Duration (RFMVD) 688
Agus Sundari, Maya Silvi Lydia and Muhammad Anggia Muchtar

Optimizing Sarcasm Detection through Various Input Methods in Text Data 693
Nicholaus Jeremy, Matthew Alam, Justin Tristan Tirtawijaya and Jonathan Samuel Lumentut

American Sign Language Alphabet Recognition Using Convolutional Neural Network 698
Jefri Pangaribuan, Romindo Romindo, Aditya Mitra, Okky Barus and Sai Prashanth

Rice Disease Detection and Classification Using Mask R-CNN and DenseNet 704
Nicholaus Jeremy, Nicole Minar Widjaja, Bryan Alvis Xavier Halim Chandra and Jonathan Samuel Lumentut

The Prospect of Combining NFC Technology with Hologram Projection for Early Childhood Education 710

Maria Seraphina Astriani

Optimizing User Experience: Evaluation of Usability and Cognitive Walkthrough on Web DECART 714
Ranty Deviana Siahaan, Arlinta Barus, Paulina Panjaitan and Vistar Rajagukguk

Deciphering Key Features in Online Buying Session Prediction Using Logistic Regression and Naive Bayes 720
Arnold Aribowo and I Made Murwantara

Blockchain-based Coal Mining Concession Production Monitoring System 726
Mutiara Marpaung and Pujianto Yugopuspito

Utilizing Augmented Reality to Improve Customers' Purchase Intention in Retail Furniture Applications in Indonesia 730
Gwenda Tannia Suryasamudra, Nurul Farhanah Bt Mohd Idres, Jolin Lee, Valentheresia Valentheresia, Gunawan Wang and Anderes Gui

Fake News Classification Using SVM And Logistic Regression Methods 736
Ferawaty Ferawaty, Mangasa A. S. Manullang, and Richard Hanitio

Enhancing Diabetes Management through Mobile Applications: A Comprehensive Approach to Health Management 741
David Habsara Hareva, Vanessa Chriszella Rasubala and Benny Hardjono

Early Identification of Potential Heart Abnormalities with Decision Tree Method 746
Mardi Turnip, Imanuel Putra, Desta Telaumbanua, Albert Nicol, Abdi Dharma and Delima Sitanggang

CoRun: Application for Coaching in Indorunners Community 752
Lily Puspa Dewi

Application Of Decision Tree Algorithm In Classifying The Level Of Impulsivity In EEG Signals 756
Yennimar, Dhanny Rukmana Manday, Anita Christine Sembiring, Nurima Lumbantoruan, Arico Sempana Ginting, Ruth Marsaulina Simanjuntak, Delima Sitanggang

Utilizing Fine-Tuning ResNet-18 For Acute Leukemia Diagnosis From Blood Smear Images 762
Triandes Sinaga, Ade Candra and Bedy Purnama

Obesity Prediction: K-Nearest Neighbor vs. Support Vector Machine 768
Okky Barus, Felix Billie, Jusin Jusin, Jefri Pangaribuan and Ade Maulana

Prevalence, Devices Used, Reasons for Use, Trust, Barriers, and Challenges in Utilizing Generative AI among Tertiary Students 773
John Paul Miranda, Joseph Alexander Bansil, Emerson Fernando, Almer Gamboa, Hilene Hernandez, Myka Cruz, Roque Francis Dianelo, Dina Gonzales and Elmer Penecilla

Deep Learning in Image Classification Using Modified ResNet50 and Texture Features for Lung Cancer Detection 779
Evander Banjarnahor, Jefri Pangaribuan, Okky Barus and Romindo Romindo

Development of RLE Scorer Web App for College of Nursing at Tobruk University 785
James Neil Mendoza, Dorothy Buhat-Mendoza and Jocelyn Ampaguey

The Effect of Mobile Service Quality Dimensions in Food and Beverage Mobile Applications on Customer e-Satisfaction in Indonesia 791
Ricky Satria, Jonathan Timothy Christian, Kelven Jaya Kristanto and Tanty Oktavia

Information Technology, Organizational Culture, and Portfolio Management: A Measurement Model ... 797
Faros Zaim and Apol Subriadi

Gold Price Administration and Prediction Application using Moving Average Method 803

Alexander Setiawan

Prediction of Land Use and Land Cover (LULC) Changes for 2030 Using Time Series Data and Random Forest Algorithm 809
Evta Indra, Dheo Putranta Pandia, Tengku Nabila and Dennis Jusuf Ziegel

Effects of Social Media Marketing Towards Online Purchase of Local Perfumes in Indonesia 815
Lim Sanny

HCI Approach to Increasing E-Learning Using a Combination of Cognitive Walkthrough and Uer Centered Design 821
Baenil Huda, Kristoko Hartomo, Yessica Nataliani and Irwan Sembiring

Improving Credit Score Classification Using Long Short-Term Memory and Support Vector Machines Tuned with Whale Optimization Algorithm 827
Sebastianus Radhya, Yeremia Toemali, Francesco Jovan and Abram Prabowo

Forecasting the Stock Price of Bank Central Asia using Singular Spectrum Analysis Based Model 833
Etik Zukhronah, Winita Sulandari, Sri Subanti, Isnandar Slamet, Sugiyanto Sugiyanto and Irwan Susanto

Analyzing the Performance of Golang Web Frameworks Utilizing GORM in the Oil and Gas Industry ... 839
Karsten Lie, Maria Seraphina Astriani and Ida Manuaba

A Comprehensive Evaluation of the AR Budur Application: A TELOS Analysis 845
Audrianne Gunawan, Felix Nathanael Tjahjono, Danny Sebastian and Restyandito Restyandito

AI-Powered Badminton Shot Classification 851
Michael Salim, Winly Williamdy and Eden Steven

Optimising Plastic Waste Management: YOLO-NAS-Based Robotic Sorting and Mobile App Prototypes for Adaptive Model Training 857
Vihaan Jain, Aria Amadeus Salim and Eden Steven

Comparison Research: YOLO (You Only Look Once) Model for Indonesian Sign Language Detection Reducing Communication Inequalities..... 863
Brandon Steven, Calista Vannia Nathalie, Christoper Gerry Johanes and Puti Andam Suri

Tracking and Predicting CO2 Emission Transportation in Toba Regency 869
Humasak Simanjuntak, Esphi Hutabarat, Sintia Silaen, Agnes Marpaung and Susi Purba

Optimizing Walking Routes for Step Goals using Knapsack Algorithm 877
Susi Eva Maria Purba, Sarah Rosdiana Tambunan and Chandro Pardede

Diversity Focused Content-Based Filtering Recommendation System 881
Chandro Pardede, Parmonangan R. Togatorop, Ary Aritonang and Rosni Lumbantoruan

Prototyping an IoT-Based Smart Controlled Poultry Farm System 887
Indra Tambunan and Noel Riki Apryanto

SparkFlow: A Simple Big Data Analysis Application over Apache Spark 892
Henry Novianus Palit, Andre Gunawan and Daniel Jeremia

Blockchain-Enabled Analytics in Banking Enhancing Risk Management for the Future of the Industry .. 898
Rusdi Pratomo, Marviola Hardini, Dwi Julianingsih, Dedeh Suprianti and Qurotul Aini

The Role of User Behavior Patterns in Enhancing Fraud Detection in Online Banking: A Bibliometric Analysis 904
Pita Silvia, Qurotul Aini, Efa Ayu Nabila, Henderi Henderi and Hardjanto Nusantoro

Exploring the User Satisfaction of Gamification in Promoting Savings Among Millennials 910
Ariya Jati Kusumo, Qurotul Aini, Shofiyul Millah, Tuti Nurhaeni and Lusyani Sunarya
Big Data Analytics for Proactive Financial Fraud Detection and Prevention 916
Yehezkeil Hasudungan, Fitra Putri Oganda, Maria Daeli, Raihan Raihan and Nesti Anggraini Santoso
Exploring User Experience and Challenges with Mobile Wallet Adoption in Emerging Markets 922
Priandito Priandito, Ninda Lutfiani, Natasya Aprila Yusuf, Thomas Sumarsan Goh and Muchlisina Madani
The Role of Financial Literacy and Fintech in Promoting Financial Inclusion 928
Tri Widiyatmoko, Untung Rahardja, Nanda Septiani, Dewi Immaniar Desrianti and Muhammad Faizal Fazri
Evaluating the Effectiveness of Gamification in Mobile Banking to Increase Savings Rates 933
Tubagus Wahyu Rafiuddin, Ninda Lutfiani, Agung Rizky, Mulyati Mulyati and Galih Putra Cesna
Application of Projection Mapping and RFID in Assembly Process 939
Novie Theresia Br. Pasaribu, Markus Tanubrata, Vivi Arisandhy, Erwani Merry Sartika, Audyati Gany

Author Index 946

Preface

We are delighted to present the proceedings of the **International Conference on Quantum and Artificial Intelligence (ICTIIA) 2024**, held in Medan, North Sumatera, Indonesia, on 12th - 13th September 2024. This year's theme, "**Synergizing Quantum and Artificial Intelligence: Pioneering Future Innovations in Technology and Its Multidisciplinary Applications**," captures the essence of the rapidly evolving technological landscape. The integration of quantum computing with artificial intelligence promises groundbreaking advancements that will shape the future of various disciplines, from healthcare and finance to engineering and beyond.

This conference gathered experts, researchers, and industry leaders from around the globe to share their latest research and insights. The papers included in this proceedings book cover a broad spectrum of topics, reflecting the diverse applications of quantum technologies and AI in solving real-world challenges. Through rigorous peer-review, these papers represent cutting-edge contributions to both theoretical foundations and practical implementations in multidisciplinary fields, showcasing the potential of these two powerful technologies to revolutionize modern science and industry.

We express our heartfelt gratitude to the organizing committee, the scientific reviewers, and the presenters, whose efforts and expertise have made this event successful. We would also like to thank the conference sponsors and partners for their unwavering support. The knowledge shared and the collaborations fostered at ICTIIA 2024 are invaluable steps toward driving innovation and pushing the boundaries of technology in the years to come.

Medan, September 12-13th, 2024
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Gold Price Administration and Prediction Application using Moving Average Method

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***Abstract*—This research focuses on creating an administration and gold price prediction application using the Moving Average method for The Gold Shop Company. This application is designed to assist the store in managing store administration data, managing gold stocks, and predicting future gold prices by implementing the Simple Moving Average (SMA) method based on historical gold price data. Application testing is carried out using the User Experience Questionnaire (UEQ) method for the mobile version of the application. The implementation of the simple moving average method in predicting gold prices is also measured for accuracy by calculating the error on each price prediction data using the Mean Absolute Percentage Error (MAPE) method approach and the result is that the MAPE value is not more than 10%. This indicates that the simple moving average method has a very high level of accuracy in predicting gold prices.**

Keywords—gold price prediction, moving average, mobile application, website, store administration system

I. INTRODUCTION

The Gold Shop company is one of the gold jewelry shops in Samarinda, East Kalimantan. The Gold Shop company itself has been established since the 1980s. There are several factors or motives why customers want to buy gold, one of which is as a jewelry tool. However, apart from being a jewelry tool, there are also motives for customers to buy and sell gold as an investment tool. However, as the price of gold fluctuates and changes every day, this affects the decision of the customer and the store in determining when is the right time to buy or sell gold. Customers and the shop sometimes only guess whether the price of the gold will go up or down in the next few days, where the estimated price could be wrong or inaccurate.

There are also various requests for gold price information from customers, so the store must be ready to meet the customer's needs by knowing the gold price list on that day. Besides that, some of the customers have a desire to see the stock of gold jewelry that is available at the store without having to come to the store (which can be seen from anywhere). In order to meet customer requirements, the store usually takes photos of each gold jewelry stock that customers want to see. It is certainly inconvenient and time-consuming for the store to send gold stock photos one by one. Customers who buy and sell gold or order services from the store will have their data recorded, whether it be buy, sell, or order data. However, the store does not usually record or store the data consistently. The data that is recorded or stored is sometimes incomplete, so it can be confusing to see the history of sales, purchases, or orders.

Based on the problems described above, the solution offered is to create an application that can help Gold Shop meet customer needs by providing features in the application such as features that can predict gold prices or analyze trends in future gold price movements based on a list of historical gold prices in the past, features that can display information about the current gold price list (up to date), features that can display a list of gold stocks that are currently available (such as digital catalogues), and features that can record and store data such as sales data, purchases, orders, and financial reports in a neat, well-organized, and easy-to-understand manner.

II. LITERATURE REVIEW

A. Gold

Gold is a precious metal that is malleable and a symbol of honor, wealth, and luxury. Gold, which is usually used as a material for jewelry or valuable possessions, has also long been a popular and trusted investment instrument [4]. Real gold has several characteristics, one of which is that it has a shiny color because gold comes from the process of magmatism, which produces special mineral deposits. This type of precious metal has a sparkling and shiny yellow color, in contrast to counterfeit metals, which are usually dark yellow in color. In addition, gold is easy to shape because it is soft and malleable, non-magnetic, not easily damaged, and usually has a certificate as proof of its authenticity. Gold consists of several types, including gold bars, gold jewelry (such as necklaces, rings, bracelets, earrings, and pendants), gold coins, white gold, and others.

B. Mobile Application

Mobile applications are software designed for use on small wireless devices such as tablets and smartphones [3]. Mobile apps can be written in a variety of programming languages and frameworks and can be installed and downloaded from app stores such as the Apple App Store (for iOS operating systems) or the Google Play Store (for Android operating systems). The way a mobile application works to be used or run on the device is that once downloaded, the application is installed, stored on the device, and launched using the device's operating system. The application can communicate with the device's operating system and other built-in software components when the user opens the mobile application to access the device's hardware and services, such as the camera, GPS, Internet connection, and so on.

C. Information System

Information systems are systems that use technology and human work to support management and operational activities [1]. The purpose of developing an information

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system is to produce a product consisting of a collection of information. A system must have different types of data that can be processed so that they can be easily displayed for users to obtain information. A well-designed information system can ensure that the data is properly stored and recorded so that it can be retrieved whenever needed, thus saving time and helping an organization or user manage all the data [10].

D. Moving Average Method

The moving average method is one of the methods used as a technical analysis tool to analyze and predict stock or asset price movements [2]. In other words, this method can calculate stock prices within a certain period of time, for example, a period of 5 (1 week), 20 (1 month), 60 (3 months), or 120 (6 months), to see the movement of stock prices in the form of an average line on a graph using a mathematical formula. The moving average method is part of a lagging indicator, which means that this method explains information about market history data [5]. For example, a 20-day moving average means that the figure is an average of price movements over the past month. The longer the period used, the slower the movement of the line (lagging) compared to the price.

In the context of gold, the moving average method can also be used to predict future gold prices, as this method can read movements or changes in gold prices based on the history of gold price data in previous days. This can be used as a consideration or decision as to when it is a good time to buy or sell gold. This moving average method can be divided into several types, including simple moving average (SMA), weighted moving average (WMA), and exponential moving average (EMA) [6].

The Simple Moving Average (SMA) method is the simplest moving average method compared to other moving average methods. The way this method is calculated is by adding a series of prices over a certain period of time and then dividing by the number of periods. This method can be written as follows:

$$SMA = \frac{p_M + p_{M-1} + \cdots + p_{M-(n-1)}}{\text{n}}$$

Where:
p_M = Mth period price
n = period

The Weighted Moving Average (WMA) method is an evolution of the Simple Moving Average (SMA) method. The difference is that in the Simple Moving Average (SMA) method, each price data is assumed to have the same weight, but in this Weighted Moving Average (WMA) method, the price data is actually given a different weight, with the latest price data having a greater weight than the old data, in order to achieve higher calculation accuracy [7]. This method can be written as follows:

$$WMA_M = \frac{np_M + (n-1)p_{M-1} + \cdots + 2p_{(M-n+2)} + p_{(M-n+1)}}{\text{n} + (\text{n}-1) + \cdots + 2 + 1}$$

The Exponential Moving Average (EMA) is a type of moving average that gives greater weight and significance to the most recent data points, such as the current gold price. Due to the weighting factor, this method tends to be more sensitive to price changes than the Simple Moving Average (SMA) method. To calculate the exponential moving average (EMA), first calculate the moving average using the simple moving average (SMA) over a given period. Then calculate the weighting (smoothing) factor of the EMA; the formula is 2/(n+1). For example, for a 20-day moving average, the weighting factor is [2/(20+1)] = 0.0952. The weighting (smoothing) factor is then combined with the previous EMA to obtain the current value. Thus, the EMA gives more weight to the current price. This method can be expressed as follows:

$$EMA_{today} = EMA_{yesterday} + \alpha \times (price_{today} - EMA_{yesterday})$$

Where:
$EMA_{yesterday}$ = SMA value for the nth period
α = EMA weighting factor, formula 2/(n+1)
$price_{today}$ = Today's closing stock price or n+1

This method can also be formulated as follows:

$$EMA_t = \left[V_t \times \left(\frac{s}{1+d}\right)\right] + EMA_y \times \left[1 - \left(\frac{s}{1+d}\right)\right]$$

Where:
$EMA_t = EMA_{today}$
V_t = Value today
$EMA_y = EMA_{yesterday}$
s = smoothing
d = number of days

III. SYSTEM ANALYSIS AND DESIGN

This section will discuss further about the system analysis and design to develop the Gold Shop application.

A. Problem Analysis

Here is the list of problem analyses that the Gold Shop has:

- The price of gold is volatile, which means that the price of gold can change at any time (uncertain). This affects customers' and the shop's decisions as to when it is the right time to buy or sell gold.
- There are various requests for gold price information from customers, so the store must be ready to meet customer needs by knowing the gold price list on that day.
- The desire of some of The Gold Shop's customers is to see the stock of gold jewelry that is available at the store without having to come to the store (which can be seen from anywhere). Therefore, the store usually takes photos of various gold jewelry stocks and then sends them to the customers.
- Store data management (such as recording and storing data) is still poorly managed by the store [8].

B. Requirement Analysis

Based on the problem analyses described above, a system is needed that can help Gold Shop overcome the problems, such as:

- A program that can predict the price of gold or analyze the trend of gold price movements in the future based on a historical list of gold prices in the past.
- A program, such as a digital catalog, that can display a list of gold stocks currently available in the store, along with detailed information about the gold, such as its type, grade, weight, manufacturer, and item description [9].

- A program that can record and store data such as sales data, purchases, orders, and financial reports in an organized manner.

C. *Business Process Analysis*

The business process of Gold Shop is divided into several parts, namely:

1) Sales Process

The gold sale process between the customer and the gold shop begins when the customer comes to the shop and gives the shop the gold they want to sell. The store checks the customer's gold to see if it is real or fake and asks for a gold purchase receipt. If it does not meet these requirements, the gold will be returned to the customer. In the meantime, if the store accepts the gold that the customer wishes to sell, it will provide a price quote for that day. At this stage, the customer can negotiate the price of the gold they wish to sell with the store. If an agreement is reached, the store will accept the gold, pay the customer, and issue a sales receipt as proof of payment. This process of selling gold is shown in Fig. 1.

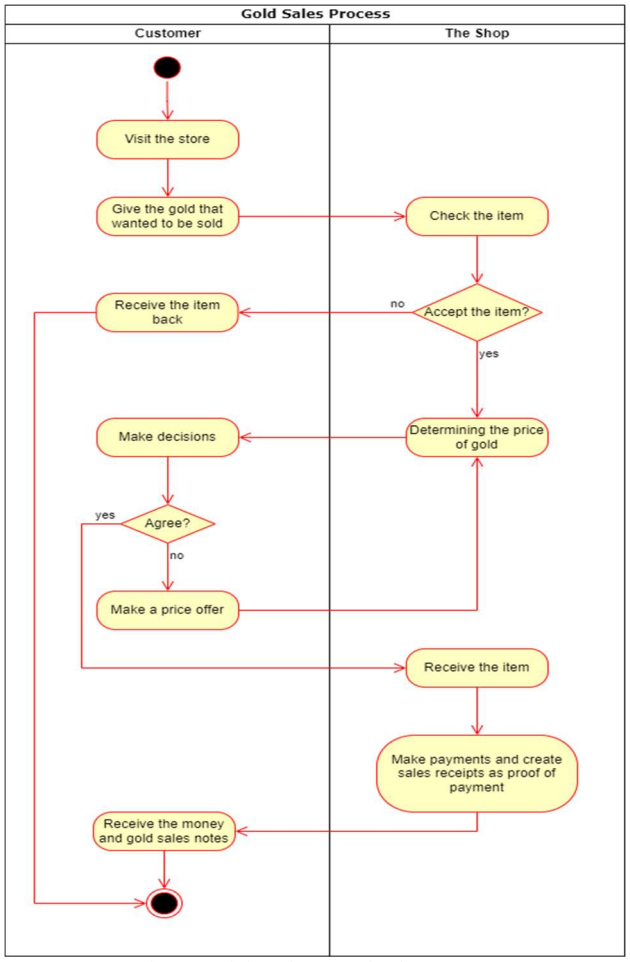

Fig. 1. Activity Diagram of Sales Process

D. *System Design*

This section shows the design of the system for the application to be built, such as the use case diagram and the entity relationship diagram.

1) Use Case Diagram

Fig. 2. below is a use-case diagram of the system that will be created for Gold Shop. There are two actors that can interact with the system, namely the store, which acts as an admin, and the store's customers, which act as users. Admins can use various features such as login, account management, inventory management to manage gold jewelry stock, order verification, provide appointment status, enter gold buying and selling data, enter gold service order data, financial reports, display a list of today's gold prices, provide gold price forecasts, and provide a gold price range to customers when they want to sell gold. Meanwhile, users can use features such as register, login, account management, and a and a digital catalog to view the various gold jewelry stocks available, filter gold jewelry stocks, and place orders for gold services such as damaged gold repair services, gold washing, gold melting, or gold jewelry model design services. In addition, the user can also use the appointment setting feature if the customer wishes to arrange a time with the store to buy and sell gold or for other purposes. The user can also use the feature to check the current gold price and get information about the price range of the gold the user wants to sell.

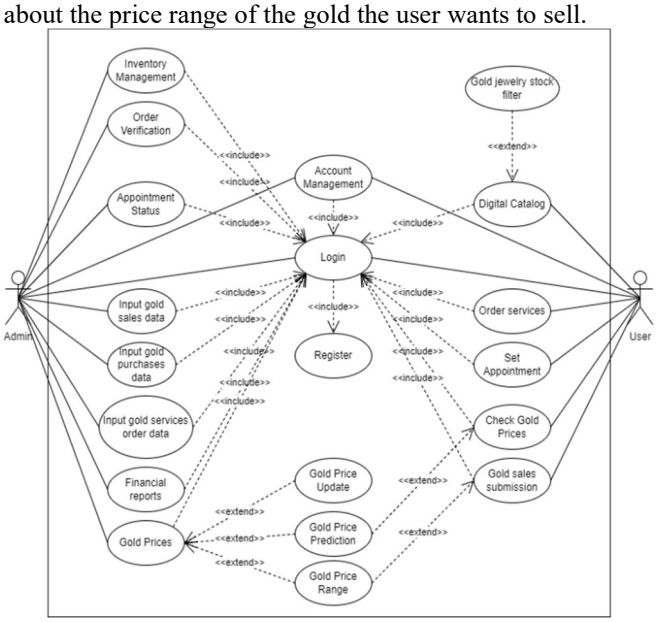

Fig. 2. Use Case Diagram

2) Entity Relationship Diagram

Fig. 3. below is a crow's foot entity relationship diagram containing tables that play a role in storing data for the Gold Shop system.

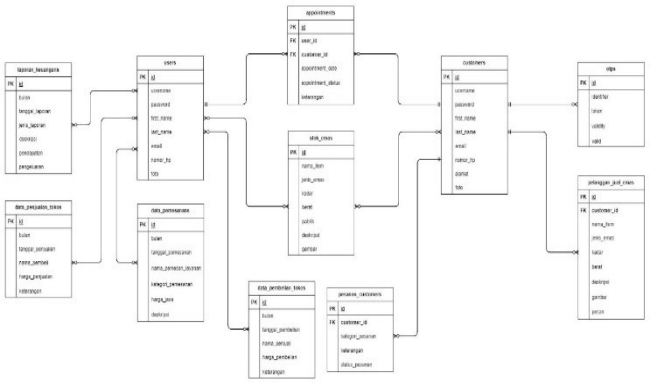

Fig. 3. Entity Relationship Diagram with Crow's Foot notation

IV. RESULT AND DISCUSSION

This section will discuss further about some of the application designs, application testing results, and testing results of the gold price prediction.

A. *Application Design*

The mobile version of the Gold Shop application page display is divided into two themes, namely the dark mode theme and the light mode theme. The mobile version of the Gold Shop application view can also adjust the screen size of the device, either portrait or landscape.

1) Home Page

The home page displays some information, one of which is today's gold price information. If the user clicks on the gold price information, the user will be redirected to today's gold price page. In addition to today's gold price information, there is also a table of gold price data over the last 7 days, showing the date and the price of gold on that date. Clicking on the table will take the user to the historical gold price data page. There are also buttons on this home page to view the gold stock currently available, such as necklaces, bracelets, rings, earrings, pendants, and precious metals. For example, if the user clicks on the bracelet button, they will be taken to the digital catalog page where the condition of the gold stock is displayed (filter), which is a list of gold stock in the form of bracelets. There is also a navigation bar at the bottom of the home page with the home, my activities, and profile buttons. The display of the home page in the mobile version of the Gold Shop application is shown in Fig. 4.

Fig. 4. Home Page on Mobile Version Application

2) Historical Gold Price Data Page

The Gold Price History page is a page that displays a list of gold price history for the last 1000 days. This gold price history list is displayed in a table with the date and gold price information for that date. On this page, there is a facility to filter the gold price data by year. For example, if the user filters the year 2022, then the list of data displayed will be a list of gold prices in 2022. The amount of gold price data loaded for each page is 20 data points. If the user wants to see the following or previous data, then the user can click on the previous or next button on the page. The display of the historical gold price data page is shown in Fig. 5.

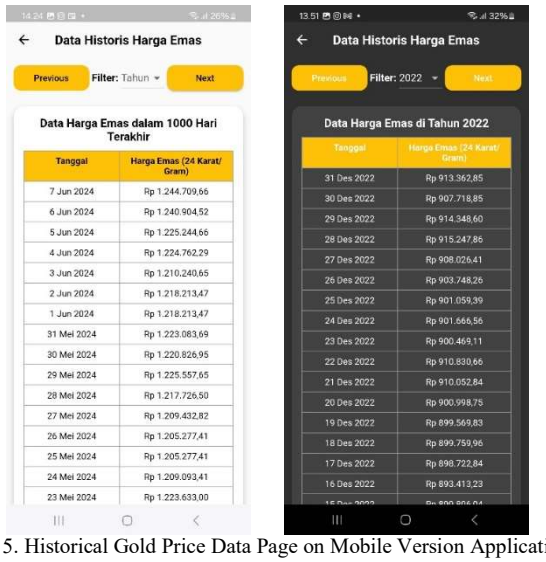

Fig. 5. Historical Gold Price Data Page on Mobile Version Application

In addition to displaying historical gold price data in tabular form, historical gold price data is also displayed in graphical form. There are functions for zooming the price data on the gold price graph, including Zoom all, which displays the gold price graph as a whole; Zoom YTD (year to date), which displays the gold price graph for the period from the beginning of the year to the present; Zoom 1m, which displays the price graph for the last 1 month; Zoom 3m, which displays the price graph for the last 3 months; and Zoom 6m (the default zoom function on the website version of the application), which displays the gold price graph for the last 6 months. The gold price chart displayed on the historical gold price data page on website version is shown in Fig. 6.

Fig. 6. Display of the Gold Price Graph on the Website Version of the Application

The display of the gold price chart changes according to the zoom chart option used by the user. In addition to the zoom chart function, the chart on the website version of this application has a predictive/analysis function for gold prices using the Simple Moving Average (SMA) method. With this method, users can find out the trend or forecast of gold prices in the future based on this gold price history data. If the user wishes to use this method, the user must enter the period according to the analysis needs (long or short term); for example, the input period is 30 days. Users can also forecast gold prices using more than one simple moving average method at the same time by entering more than one period if they want to analyze or forecast gold prices using a combination of these periods. The graph generated by

implementing one simple moving average method is shown in Fig. 7, while the graph generated by implementing more than one simple moving average method with different periods is shown in Fig. 8.

Fig. 7. Gold Price Chart Display with Gold Price Prediction Method with 1 SMA on the Website Version of the Application

Fig. 8. Gold Price Chart Display with Gold Price Prediction Method with More than 1 SMA on the Website Version of the Application

3) Digital Catalog Page

The digital catalog page is a page that displays the gold stock that is currently available. Users can view different types of gold as a whole or by filtering the gold stock; for example, if users filter by necklaces, then the system will only display a list of gold stock in the form of necklaces on the digital catalog page. Users can also view the details of the gold stock by clicking on the item that users wish to view the details of. The digital catalog page is shown in Fig. 9.

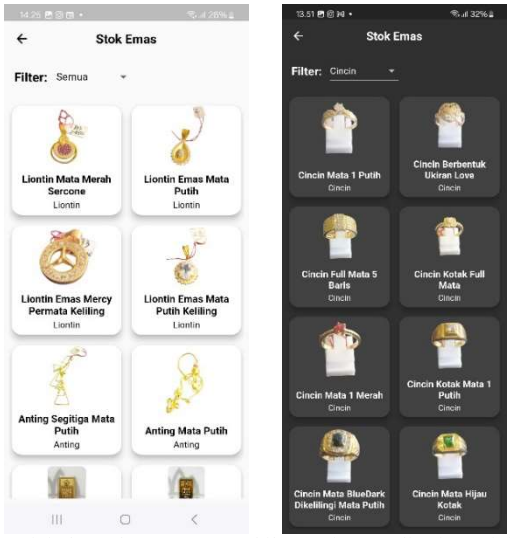

Figure 9. Digital Catalog Page on Mobile Version Application (Light Mode & Dark Mode)

B. Application Testing Results Data

The Gold Shop application that has been created, both the website version and the mobile version, needs to be further evaluated to find out how good the application is. The evaluation of the application will largely be from the user's point of view when using the application. In order to conclude how good and effective the application is, participants need to test the Gold Shop application. For the mobile version of the application, after testing the application, users are asked to complete a user testing questionnaire for the Gold Shop mobile application. There were 22 participants who took part in testing and completing questionnaires. The questions in the questionnaire were taken from the User Experience Questionnaire (UEQ) method, which can be accessed via the website https://www.ueq-online.org/.

Data from respondents or participants is then processed using the UEQ data analysis tool. Respondent or participant data contained in the questionnaire can be entered into the "Data" sheet in the Excel file. The data will be processed to produce a score or average value for each UEQ method rating scale. To find out how good the average value obtained is, the data can be compared with the benchmark data contained in the benchmark column or sheet in the Excel file. The results of the comparison between questionnaire data and benchmark data in tabular form can be seen in Table 1, while the results of the comparison between questionnaire data and benchmark data in graphical form can be seen in Fig. 10.

Table 1. Table of Comparison Results of Questionnaire Data with Benchmark Data

Scale	Mean	Comparison to Benchmark	Interpretation
Attractiveness	1,80	**Good**	10% of results better, 75% of results worse
Perspicuity	1,89	**Good**	10% of results better, 75% of results worse
Efficiency	1,88	**Good**	10% of results better, 75% of results worse
Dependability	1,75	**Excellent**	In the range of the 10% best results
Stimulation	1,13	**Above Average**	25% of results better, 50% of results worse
Novelty	0,73	**Above Average**	25% of results better, 50% of results worse

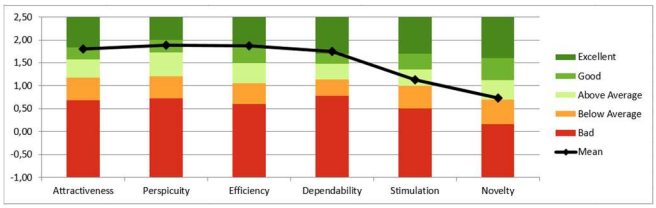

Fig. 10. Graph of Comparison Results of Questionnaire Data with Benchmark Data

From the results of the comparison between the questionnaire data and the benchmark data, it can be seen that for each rating scale, the mobile version of the Gold Shop application scores quite well and exceeds the average rating when compared to the benchmark data, so it can be concluded that the mobile version of the Gold Shop application has been successfully designed and developed.

V. CONCLUSION

Based on the test results of the application, it can be concluded that the implementation of the moving average method in predicting the gold prices in the future has been successfully carried out and has a high level of accuracy, as the mean absolute percentage error (MAPE) value is not more than 10%. This has been demonstrated by calculating the error for each gold price forecast with different parameters, starting from the short, medium, and long terms. The period index used as a test in predicting gold prices includes the 10-day period (short term) with a MAPE of 0.87%, the 50-day period (medium term) with a MAPE of 2.04%, and the 200-day period (long term) with a MAPE of 4.74%.

In addition, all features of the Gold Shop application, both the website version and the mobile version, can function properly. The application has also gone through the testing phase by conducting user testing. The mobile app version was tested by 22 participants in application trials. The participants then completed a questionnaire about the use of the application. The result is that the mobile app version gets good results on every scale of evaluation and exceeds the average evaluation when compared to the data of the benchmark, so it can be concluded that the mobile version of the Gold Shop application has been successfully created and developed properly. As for user testing and evaluation of the website version of the application, this is done directly by the shop owner as a representative of the shop. The results of user testing and evaluation of both the website and mobile versions of the application are that, overall, the Gold Shop application is easy to use and understand, and the features included in the application can facilitate the store's performance in meeting customer needs.

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