Indian Journal of Information Sources and Services
ISSN: 2231-6094 (P) Vol.14, No.2, 2024, pp.153-159

DOI: https://doi.org/10.51983/ijiss-2024.14.2.22

Development and Management of E-Commerce Information Systems Using Edge Computing and Neural Networks

Dr.K. Yemunarane[1], Dr.G. Chandramowleeswaran[2], Dr.K. Subramani[3], Ahmed ALkhayyat[4] and G. Srinivas[5]

[1]Assistant Professor, Department of Computer Science, KGiSL Institute of Information Management, Coimbatore, India

[2]Assistant Professor, Department of Commerce and Business Administration, Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Avadi, Chennai, India

[3]Senior Assistant Professor - Operations, Vignana Jyothi Institute of Management, Bachupally, Hyderabad, India

[4]College of Technical Engineering, The Islamic University, Najaf, Iraq

[5]Assistant Professor, Department of Information Technology, Aditya Engineering College, Surampalem, India

E-mail: [1]yemunaranekumaravel21@gmail.com, [2]mowleehul@gmail.com, [3]ksubramani12@gmail.com, [4]ahmedalkhayyat85@iunajaf.edu.iq, [5]srinivas.g@aec.edu.in

ORCID: [1]https://orcid.org/0000-0003-3258-9502, [2]https://orcid.org/0000-0002-1293-1043, [3]https://orcid.org/0000-0001-9676-2701, [4]https://orcid.org/0000-0002-0962-3453, [5]https://orcid.org/0009-0004-4865-5062

(Received 15 April 2024; Revised 16 May 2024; Accepted 08 June 2024; Available online 26 June 2024)

Abstract **- E-commerce refers to implementing e-commerce on mobile devices, cell phones, and mobile Internet connections. The fast advancement of mobile electronic gadgets and mobile Internet connections has facilitated the emergence of this new e-commerce market. The e-commerce systems contain several concealed client behavior data and forthcoming growth patterns. Data mining technologies extract valuable data and facilitate the growth of e-commerce. This article focuses on studying mobile e-commerce systems within the framework of edge computing, specifically in the setting of industrial clusters. This study examines the importance and benefits of data mining techniques in implementing e-commerce management platforms using neural networks. It also evaluates the corresponding methods of data mining and predicts purchasing trends. The study has used the benefits of grouping and back propagation neural network approaches in data analytics to categorize goods details, buying tastes, and related data. The advantage of neural networks in processing nonlinear patterns is employed to forecast forthcoming buying power. The findings demonstrate that data analytical methods and neural networks exhibit higher precision in predicting the buying pattern. The correlating factor between actual and projected usage information was 0.98, with the highest relative average inaccuracy of 2.4%. Data mining technologies effectively extract previously unrecognized relevant data and anticipated buying patterns in e-commerce platforms. Neural networks have a solid ability to predict future consumption capacity and consumption behaviors accurately.**

Keywords: **E-Commerce, Information Systems, Edge Computing, Neural Networks**

I. INTRODUCTION

Clusters of industries are a prevalent economic phenomenon worldwide. Industrial regions are geographic concentrations of connected enterprises that assemble due to unique economic activity. The occurrence of industrial centers has a rather lengthy history (Xu et al., 2021). The occurrence of industrial accumulation in the context of the coasts after reforming and opening up is observed in places such as the delta of the Yangtze River, where a centralized manufacturing sector has emerged, forming a collective region. Extensive local and international research investigations have consistently shown that industrial groups provide significant benefits over non-cluster firms. The primary indication is that businesses inside the cluster exhibit high competitiveness, experience rapid growth, and possess robust innovation skills. The concept of the whole of parts being more significant than the total economic impact of the organization's framework is referred to here.

Industrial cluster businesses have significantly decreased production expenses, raised production efficacy, and concurrently mitigated survival risks, dramatically augmenting market fundamental competitiveness (Nair et al., 2021). Domestic and international industrial groups have seen significant growth in recent years. These diverse groups have expanded globally, forming the economic spatial framework for global development. With the backing of international organizations, the development plan for clusters of factories is emerging as a new trend and a powerful catalyst for the growth of different nations. China's industrial clusters are experiencing a period of unprecedented growth. The encouragement and promotion of establishing clusters of factories is emerging as a novel approach to local economic development.

The fast advancement of the latest devices, networks, and data analytics are extensively utilized in numerous human endeavors (Zhang & Tao, 2020). The practice and academic community have emphasized the smart evolution of e-commerce administration. Multiple organizations and enterprises have achieved substantial advancements in innovative e-commerce.

Data mining methods effectively use their algorithmic strengths to extract the implicit temporal and spatial information included in the information using grouping and Bessell methods (Samal & Hashmi, 2024). The collected data of the online administration method exhibits a temporal and spatial correlation, making it suitable for use in online systems (Suresha & Ramesha, 2019).

In the contemporary digital age, a vast array of pertinent information exists in every aspect of human existence. Man finds discovering this knowledge and its significance challenging, but data mining tools can use it (Sunhare et al., 2022). Modern e-commerce will increasingly focus on effectively obtaining valuable information from complicated and disorganized data, enabling correct decision-making, and implementing intelligent e-commerce management platforms. Business executives' main challenges are correctly categorizing and gathering this information and determining the growth path based on several data sources (Li & Lei, 2022). The data and knowledge from internal and external sources inside the organization are undergoing significant transformations. The conventional business analysis job is no longer sufficient to fulfill the enterprise's need for timely information upgrades. An efficient e-commerce management approach is crucial for the organization (Liu et al., 2021). Humans have extensively used e-commerce for various purposes, such as purchasing goods, medical services, and office work. However, the potential of this data has yet to be thoroughly explored. It is logical to investigate the significance and direct future patterns thoroughly (Vignoli et al., 2020).

II. BACKGROUND

Some studies have been conducted on using Big Data Analytics (BDA) and neural networks in online shopping administration. Chou et al. utilized the vector approach to examine the relationship among consumer segments and purchasing behavior (Chou et al., 2020). This technique utilizes statistical methods to categorize and summarize data on customers' daily spending habits and brand choices (Uchida et al., 2019). The result demonstrates that this approach can extract valuable and precise data from a vast volume of consumer and shopping data. It assists e-commerce enterprises in developing rational and successful logistics management strategies.

Zhang et al. developed an advanced BDA and decision-making method that incorporates data gathering and maintenance, BDA and evaluation, and the creation of strategies (Zhang et al., 2022). The impact of buyer psychological and several elements on the BDA process. Luo et al. used edge computation techniques to enhance the architecture of the distribution chain (Luo, 2021). This model can create a fuzzy neural network that relies on the supply chain (Rika et al., 2023). The projected score of the price strategy aligns well with the intended value, demonstrating the precision and viability of this approach in e-commerce. Negi et al. utilized Field Programmable Gate Array (FPGA) analytic technologies and a comprehensive BDA to develop a managerial method between China and Japan based on customer preferences and the inherent features of the industry (Negi et al., 2021).

Mou et al. introduced a model to analyze consumer behavior in e-commerce sites (Mou & Benyoucef, 2021). This model aims to enhance customer happiness and boost revenues by improving the service quality of e-commerce systems. Moghaddasi et al. thoroughly excavated prospective customer demographic and behavioral data (Moghaddasi et al., 2021). They developed an intelligent identification of clients model to quickly identify the link between consumers and their demands. In utilized machine learning to create a consumer lifespan model that considers the score association among items and consumers (Bauer & Jannach, 2021).

They built a consumer score model depending on buying patterns. The technology is implemented to forecast the worth of internet consumers daily (Arora, 2024). This is a practical online purchasing managing approach. Kushwaha et al. used sophisticated BDA techniques and conventional searching approaches to investigate the significance of BDA in comprehending consumer behavior (Kushwaha et al., 2021). The study indicated a significant association between consumer behavior and the time dimension. Based on the literature analysis provided, it is evident that most research focuses on categorizing data within e-commerce. It does not extend their predictions to e-commerce.

This article utilizes the clustering technique to categorize and anticipate the consequences of consumer behavior data, depending on its features (Jelena & Srđan, 2023). This approach effectively achieves the smart processing of buying data. Due to the fast advancement of BDA and purchasing history across businesses, relevant information that can be extracted and employed has surfaced (Li & Xiao, 2021). The advancement of software and instruments has facilitated data extraction and machine learning technologies in online purchasing platforms, providing great convenience and efficiency for individuals. The technology for collecting big data has also seen significant advancements.

The method quantifies customer value by examining customer behavior, such as purchase history and interest in goods. It categorizes customers based on time, rate, and purchase amount. Extracting behavioral information enables proactive suggestions through e-commerce systems that suggest goods (Vivek et al., 2022). As science and technology continue to advance, implementing an intelligent e-commerce administration mode is expected to become a significant institutional trend and an unavoidable response to high market demand. Neural networks provide substantial

benefits in forecasting future patterns and can provide valuable data for e-commerce operations (Pan & Zhou, 2020).

Kostis et al. devised an unsupervised learning system to extract commonly sought-after product features from the descriptions of product pages across various e-commerce websites (Kostis et al., 2023) The methodology suggested in this research differs from previous information extraction methods by considering the widespread acceptance of product characteristics. It can identify popular product characteristics from customer evaluations and establish connections between item characteristics and these popular characteristics (Camgözlü & Kutlu, 2023). This structure uniquely connects the word used in the product detail page with the terms used in the consumer's review. While the experimental portion of the research has included thorough trials and shown the structure's efficiency, it has been determined that its efficacy is insufficient, and there is a need to enhance the framework's resilience. Prior research has shown that trust significantly influences customers' inclinations to make purchases. Muzammal et al. evaluated the route model to offer Internet providers practical methods for enhancing trust (Muzammal et al., 2020). The route model assesses three primary dimensions of trust: ability, honesty, and compassion. They evaluated the total influence of customer confidence. This article examines the several origins of trust, including customer attributes, corporate attributes, website facilities, and the influence of consumer contact on the extent of trust. An inherent limitation is the need for a larger sample of information to be used in the analysis procedure, which hinders the comprehensive explanation of the issue.

III. Proposed Method for E-Commerce Information Systems

3.1. System Architecture

Mobile edge technologies facilitate the execution of Mobile Edge Computing (MEC) applications as software objects on MEC hosts, serving as the foundation for executing apps. MEC programs operate as virtual machines on a virtualization infrastructure, which comprises a data platform that imposes traffic rules from mobile edge systems and directs traffic between the program's forest networks and the outside networks. Host-level control encompasses the administration of mobile platform edge and virtualization facilities. The former is accountable for overseeing the entire life cycle and regulatory requirements of online retail applications, such as e-commerce consumer management systems, company licenses, flow rules, and domain name systems resolution of disputes. The latter is liable for the distribution, leadership, and release of virtualization infrastructure assets, including storage, computing, and network connections. Figure 1 displays the architectural diagram.

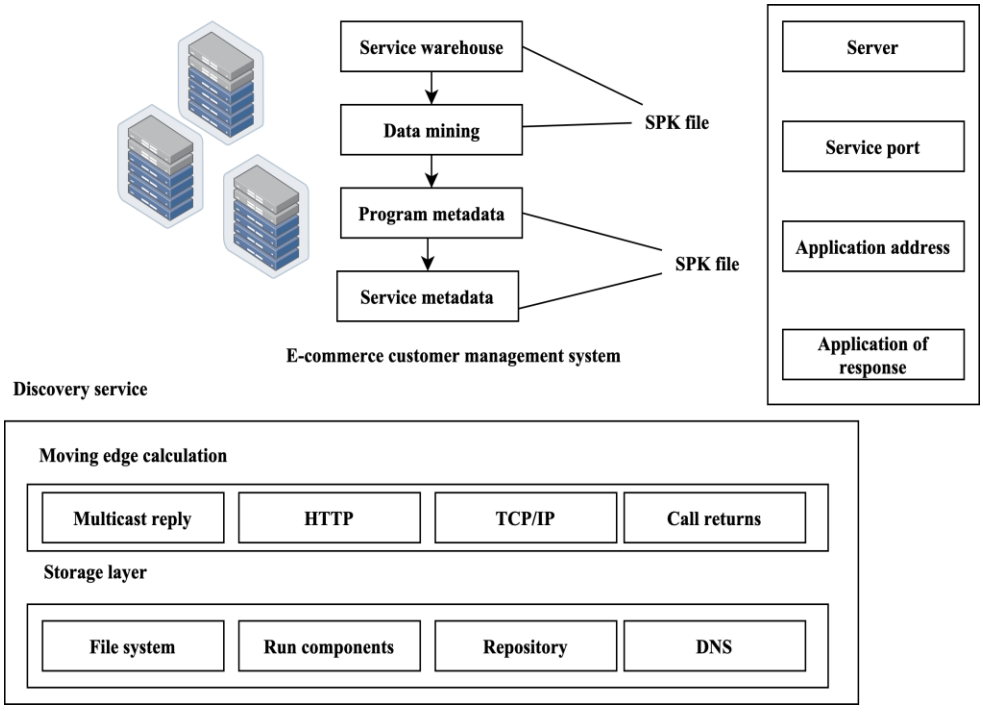

Fig. 1. The Architecture of the Proposed Method

The e-commerce consumer administration system of edge computing is structured into three levels: mobile edge computing stage, portable edge e-commerce customer platform host stage, and network-level organization, as seen in Figure 2. The host level of the wireless edge e-commerce consumer system is the fundamental component of the structure, including the mobile edge hosting and host administration. A virtualization facility can supply a program with computing, storage, and network capabilities and ongoing access and storage to necessary information. It

consists of a data-transmitting plane that handles data-forwarding policies among the platform and each application, assistance, and network circulation.

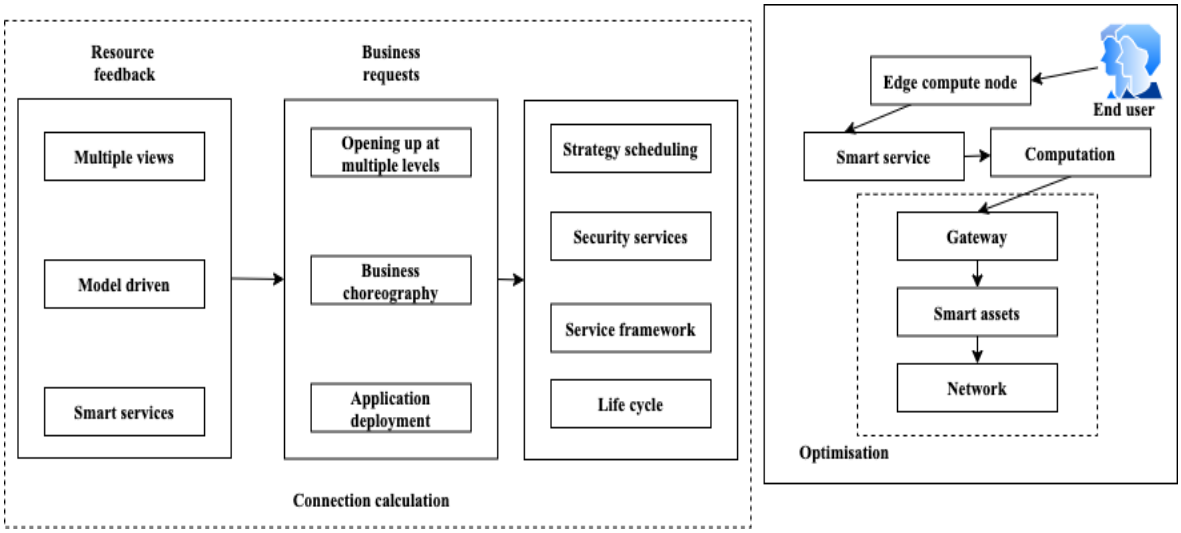

Fig. 2 E-commerce Consumer Model of the Proposed Method

The Mobile Edge (ME) platform accepts traffic forwarding guidelines from the ME platform supervisor, mobile edge programs, or mobile edge applications. It transmits commands to the receiving plane according to the received rules. The mobile edge platform facilitates the setup of local Domain Name System (DNS) proxies to reroute data traffic to the appropriate apps and services. The mobile edge framework can communicate with other mobile edge devices via reference points. These references link other mobile edge platforms within the cooperation mechanism for dispersed MEC networks.

Intelligent service is built upon the model-driven unified service structure. It achieves the synchronization of creating and deploying intelligence by utilizing the building service structure and installation functioning service structure. This allows for the consistent automation of software growth and installation activities. Smart business orchestration defines complete business processes using business support features to achieve company flexibility. Linked computing employs a simplified structure that protects services from the intricate nature of edge-intelligent dispersed construction. It enables automated management and visualization of functioning, information, and communication installation and operations.

It facilitates intelligent interaction among computing resource companies and business requirements. The Edge Computing Node (ECN) can connect to many different connections, enabling real-time processing and reaction and ensuring security by integrating software and hardware components. The three-tier concept is primarily designed for situations when services are implemented in several dispersed locations, and the business operations in each zone are relatively limited. Examples of such conditions include deploying intelligent street lighting, smart stairs, and intelligent preservation systems. Once the smart asset has been processed regionally, various service information forms are collected and combined at the intelligent gateways in the north-south direction. The smart gateway physically handles real-time service demands and consolidates non-real-time data before transmitting it to the cloud for analysis.

3.2. Data Mining

Data mining technology is an automated categorization technique that identifies more relevant groups from a vast quantity of gathered data. The information collected exhibits significant feature variations, necessitating the preprocessing stage of data mining. It determines the most effective categorization procedure using grouping, decision trees, and customized model hyperparameters. It establishes the correlation between the information and serves as the fundamental data for forecasting future client behavior. Non-dependent information, often known as data with multiple dimensions, is relatively straightforward. Dependent information, often known as dependence, refers to the connection between information components that undergo a specific change in association. Data mining categorizes this connection into two distinct types: implicit dependency and explicit reliance.

Data mining technologies are very compatible with e-commerce. E-commerce information encompasses several correlations, including the connection between client purchase statistics, consumption volume, personal consumption rate, and seasonal patterns. Computing has furnished several open-source method libraries and guiding methodologies for data mining tactics in e-commerce administration. One applies multiple algorithmic rules to handle data from various sources and eventually identifies an algorithm that aligns with the specific properties of the information in question.

3.3. Neural Network Model

The Back Propagation (BP) neural network is a prominent Artificial Neural Network (ANN). It has an input, many hidden, and an output stage with multiple nodes. Each node represents a neuron, and weights link the nodes in the lower and higher levels. The nodes within each layer are entirely interconnected, but there are no connections between nodes in the same layer. A typical example of BP neural networking is a three-layer network structure with a concealed layer, as seen in Figure 1.

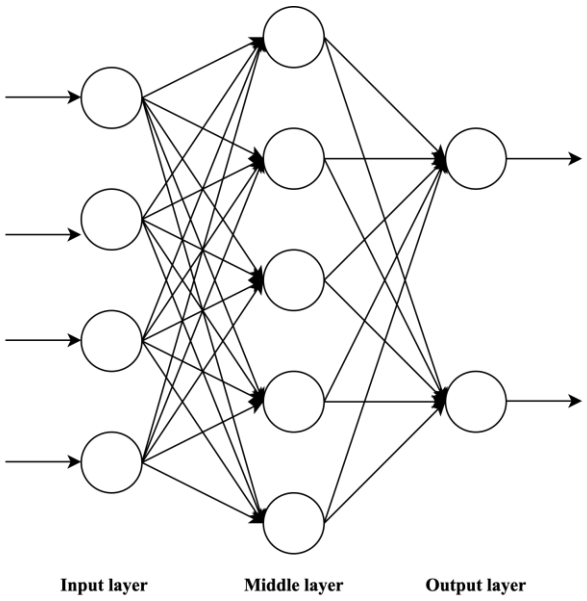

Fig. 3 Neural Network Architecture

The connection between the result o_x and source $o_{x-1}, o_{x-2}, \cdots, o_{x-k}$ mathematically be described in an NN model utilizing the equation that follows:

$$o_x = w_0 + \sum_{i=0}^{N-1} w_i f\left(w_{0_i} + \sum_{j=0}^{M1} w_{ji} o_{x-j}\right) + r_x \qquad (1)$$

The equation involves model variables w_{ji} and w_i, where N denotes the total amount of nodes in the concealed layer and M denotes the amount of nodes in the input layer of the framework. The function f is used for conversion. The function frequently utilized is defined as $f(i) = \frac{1}{1+\exp(-i)}$.

The BP neural network approach represents the linear function translating between the series' source and result o_x of the preceding observing value.

$$o_x = f(o_{x-1}, o_{x-2}, \cdots, o_{x-k}, w) + r_x \qquad (2)$$

The variable vector w represents all models, whereas the function f(·) is defined by the network architecture and weight variables [24, 25].

IV. Results and Discussion

4.1. Data Collection

Research on the collaboration between clusters of industries and supply chains is conducted by studying firms. Therefore, the survey material for this study should adhere to the following fundamental criteria:

(1) Choosing a manager, worker, or management personnel with an extensive understanding of the company's circumstances is advisable rather than opting for random individuals to assume the role.
(2) The selection of the appropriate industrial clusters for a company is often determined by its industry. It is commonly observed that industrial clusters tend to have many firms with no specific upper limit. This arrangement generally aligns with the actual conditions of the business.
(3) The company completing the survey should own a database or webpage that offers service data. This means that if the e-commerce application is efficient, it facilitates online interactions and transactions with other business partners.
After analyzing the principles above about real-life scenarios, this survey is categorized into two routes: WeChat, email, online data gathering from company web pages, and in-person visits to enterprises. The formally organized surveys were disseminated between mid-to-late January and the beginning of April and were gathered mainly in Zhejiang and other areas. A total of 319 surveys were collected, of which 54 were deemed invalid. A total of 260 valid surveys were accessible. The rate of remission was 84%.

4.2. Survey Reliability Test

The testing results for the total valid sample indicate that the correlation value for every correction item is about 0.5 for the number of measurement items relating to each variable. This suggests that the correlation for the whole collection is quite strong. Since the average value for every question is consistently over 0.5, and the overall Alpha value for every variable in the survey is about 0.7, no duplication is present after correction. Evaluate the information contained in the sample. When the absolute levels of skewness and kurtosis fall within the range of 3 and 10, it suggests that the sample closely adheres to the normal distribution. The democratic distribution of workers is shown in Table I. The study's findings, derived from the sample data, indicate that the absolute level of skewness for each item falls within the range of 0 to 2, while the absolute amount of kurtosis falls within the range of 0 to 3. The prerequisite for a typical distribution is fulfilled, and the subsequent step has fulfilled the fundamental criteria for empirical evaluation. The dispersion of company sales is represented in Table II.

TABLE I DISPERSION OF THE WORKERS

Number of employees	Frequency	Percentage (%)
Lower than hundred person	87	32.83
100 to 500 person	55	20.755
500 to 1000 person	38	14.34
Higher than 1000 person	85	32.075

TABLE II DISTRIBUTION OF COMPANY SALE ANALYSIS

Sales scale	Frequency	Percentage (%)
Lesser than 2 million	34	12.83
2 to 20 million	81	30.566
20 to 50 million	57	21.509
Higher than 50 million	93	35.094

TABLE III JOB TYPE ANALYSIS

Job type	Frequency	Percentage (%)
Senior manager	64	24.151
Middle worker	91	34.34
Grassroots worker	46	17.358
Corporate worker	63	23.774

The objective of analyzing job groups as control factors is to assess the varying impact of various jobs on different aspects of e-commerce and supply chain cooperation. Table III displays the count of distinct job groups examined in the sample information.

TABLE IV E-COMMERCE APPLICATION ANALYSIS

Job type	Information integration	Network communication	Electronic transaction
Senior manager	3.86	4.12	3.65
Middle worker	3.95	3.67	3.92
Grassroots worker	4.26	3.94	4.03
Corporate worker	3.75	3.42	3.95

TABLE V SUPPLY CHAIN COLLABORATION ANALYSIS

Job type	Information integration	Network communication	Electronic transaction
Senior manager	4.25	3.76	4.05
Middle worker	4.75	3.85	4.16
Grassroots worker	4.27	4.12	4.26
Corporate worker	4.52	4.75	4.62

Based on the findings in Tables IV and V, there are no discernible variations in many facets of e-commerce and supply chain cooperation when viewed from multiple angles. Tables VI and VII provide a more in-depth examination of several job groups about electronic commerce and supply chain cooperation.

TABLE VI VARIANCE ANALYSIS OF E-COMMERCE APPLICATION

Job type	Information integration	Network communication	Electronic transaction
Senior manager	0.95	0.65	0.68
Middle worker	0.57	0.75	0.72
Grassroots worker	0.83	0.78	0.76
Corporate worker	0.79	0.74	0.81

TABLE VII VARIANCE ANALYSIS OF SUPPLY CHAIN COLLABORATION

Job type	Information integration	Network communication	Electronic transaction
Senior manager	0.75	0.68	0.75
Middle worker	0.79	0.71	0.65
Grassroots worker	0.74	0.64	0.69
Corporate worker	0.78	0.67	0.75

The test findings for the homogeneity of variation in many aspects of e-commerce apps and supply chain synergies must satisfy the statistically significant threshold and fulfill the standards. Sample diversity has yet to achieve a substantial level. It is scientifically vital to comprehend e-commerce applications and promote collaboration within the supply chain among personnel at different levels (senior, central, grassroots, and business) across diverse vocations. There was no discernible difference.

V. CONCLUSION AND FINDINGS

Technological advances and big data have facilitated the fast growth of e-commerce technologies. Utilizing the forecasting abilities of BDA with the BP neural network is advantageous for the online purchasing platform. Using this valuable data, it can extract customer preferences, buying power, and other pertinent details and forecast future patterns. This capability is very advantageous and significant for the growth of businesses and even corporations.

Classifying and predicting in the realm of e-commerce is a laborious undertaking. Most e-commerce prediction and forecasting tasks rely on neural network techniques. More research should be conducted specifically to predict classification outcomes. This article utilizes distance-based grouping and neural networks to categorize and forecast customer behavior in e-commerce. It incorporates features from collected databases, such as consumer buying rate, purchase amount, and tastes, to improve categorization and e-commerce practices. The forecast has an identifiable practical utility. This research first employs data mining methods, including grouping, and naïve Bayesian classification is used to analyze customer purchase data and extract essential information. Neural networks forecast customers' future buying power, yielding favorable outcomes.

The linear relationship among the projected score and the actual score of the consumer's score standards has achieved a higher level of precision, with a correlation coefficient of 0.98. The margin of error for the forecasted value falls within 2%, that is deemed sufficient for the online purchasing tool. This research forecasts the worth of consumers by analyzing their activities. The chosen clustering algorithm and neural network framework provide strong predictive and

categorization skills, serving as a valuable benchmark for other areas of e-commerce administration.

REFERENCES

[1] Arora, G. (2024). Desing of VLSI Architecture for a flexible testbed of Artificial Neural Network for training and testing on FPGA. *Journal of VLSI Circuits and Systems*, *6*(1), 30-35.

[2] Bauer, J., & Jannach, D. (2021). Improved customer lifetime value prediction with sequence-to-sequence learning and feature-based models. *ACM Transactions on Knowledge Discovery from Data (TKDD)*, *15*(5), 1-37.

[3] Camgözlü, Y., & Kutlu, Y. (2023). Leaf Image Classification Based on Pre-trained Convolutional Neural Network Models. *Natural and Engineering Sciences*, *8*(3), 214-232.

[4] Chou, S. F., Horng, J. S., Liu, C. H. S., & Lin, J. Y. (2020). Identifying the critical factors of customer behavior: An integration perspective of marketing strategy and components of attitudes. *Journal of Retailing and Consumer Services*, *55*, 102113. https://doi.org/10.1016/j.jretconser.2020.102113

[5] Jelena, T., & Srđan, K. (2023). Smart Mining: Joint Model for Parametrization of Coal Excavation Process Based on Artificial Neural Networks. *Archives for Technical Sciences*, *2*(29), 11-22.

[6] Kostis, I. A., Sarafis, D., Karamitsios, K., Tsolaki, M., & Tsolaki, A. (2023). An E-Commerce Conversational Virtual Assistant in Service of Mild Cognitive Impairment Patients. *In IEEE Symposium on Computers and Communications (ISCC)*, 367-372.

[7] Kushwaha, A. K., Kar, A. K., & Dwivedi, Y. K. (2021). Applications of big data in emerging management disciplines: A literature review using text mining. *International Journal of Information Management Data Insights*, *1*(2), 100017. https://doi.org/10.1016/j.jjimei.2021.100017

[8] Li, B., & Lei, Q. (2022). Hybrid IoT and Data Fusion Model for e-Commerce Big Data Analysis. *Wireless Communications and Mobile Computing*, *2022*(1), 2292321. https://doi.org/10.1155/2022/2292321

[9] Li, Q., & Xiao, R. (2021). The use of data mining technology in agricultural e-commerce is under the background of 6G Internet of Things communication. *International Journal of System Assurance Engineering and Management*, *12*, 813-823.

[10] Liu, W., Zhang, J., Wei, S., & Wang, D. (2021). Factors influencing organizational efficiency in a smart-logistics ecological chain under e-commerce platform leadership. *International Journal of Logistics Research and Applications*, *24*(4), 364-391.

[11] Luo, X. (2021). Design and Implementation of Decentralized Swarm Intelligence E-Commerce Model Based on Regional Chain and Edge Computing. *Complexity*, *2021*(1), 5595002. https://doi.org/10.1155/2021/5595002

[12] Moghaddasi, M., Marín-Morales, J., Khatri, J., Guixeres, J., Chicchi Giglioli, I. A., & Alcañiz, M. (2021). Recognition of customers' impulsivity from behavioral patterns in virtual reality. *Applied Sciences*, *11*(10), 4399. https://doi.org/10.3390/app11104399

[13] Mou, J., & Benyoucef, M. (2021). Consumer behavior in social commerce: Results from a meta-analysis. *Technological Forecasting and Social Change*, *167*, 120734. https://doi.org/10.1016/j.techfore.2021.120734

[14] Muzammal, S. M., Murugesan, R. K., & Jhanjhi, N. Z. (2020). A comprehensive review on secure routing in the internet of things: Mitigation methods and trust-based approaches. *IEEE Internet of Things Journal*, *8*(6), 4186-4210.

[15] Nair, A., Singh, P. J., Bhattacharya, A., & Pal, S. (2021). Withstanding the economic recession: Examining the efficacy of manufacturing strategy alignment and process integration. *International Journal of Production Economics*, *231*, 107810. https://doi.org/10.1016/j.ijpe.2020.107810

[16] Negi, A., Raj, S., Thapa, S., & Indu, S. (2021). Field programmable gate array (FPGA) based IoT for smart city applications. *In Data-Driven Mining, Learning and Analytics for Secured Smart Cities: Trends and Advances*, 135-158.

[17] Pan, H., & Zhou, H. (2020). Study on convolutional neural network and its application in data mining and sales forecasting for E-commerce. *Electronic Commerce Research*, *20*(2), 297-320.

[18] Rika, R., Bob, S.R., & Suparni, S. (2023). Comparative Analysis of Support Vector Machine and Convolutional Neural Network for Malaria Parasite Classification and Feature Extraction. *Journal of Wireless Mobile Networks, Ubiquitous Computing, and Dependable Applications*, *14*(3), 194-217.

[19] Samal, P., & Hashmi, M. F. (2024). Role of machine learning and deep learning techniques in EEG-based BCI emotion recognition system: a review. *Artificial Intelligence Review*, *57*(3), 1-66.

[20] Sunhare, P., Chowdhary, R. R., & Chattopadhyay, M. K. (2022). Internet of things and data mining: An application-oriented survey. *Journal of King Saud University-Computer and Information Sciences*, *34*(6), 3569-3590.

[21] Suresha, G. P., & Ramesha. (2019). Availability of Library Resources and Services in Environmental Information System (ENVIS) Center Libraries in South India: A Study. *Indian Journal of Information Sources and Services*, *9*(2), 91–96.

[22] Uchida, N., Sato, G., & Shibata, Y. (2019). Device-to-Device Communication based DTN for Disaster Information System by using Emergent User Policy and Locational Information. *Journal of Internet Services and Information Security*, *9*(3), 41-51.

[23] Vignoli, D., Bazzani, G., Guetto, R., Minello, A., & Pirani, E. (2020). Uncertainty and narratives of the future: A theoretical framework for contemporary fertility. *Analyzing contemporary fertility*, 25-47.

[24] Vivek, V., Mahesh, T. R., Saravanan, C., & Kumar, K. V. (2022). A novel technique for user decision prediction and assistance using machine learning and NLP: A model to transform the E-commerce system. *In Big data management in Sensing*, *River Publishers*, 61-76.

[25] Xu, X., Lu, Y., Vogel-Heuser, B., & Wang, L. (2021). Industry 4.0 and Industry 5.0—Inception, conception and perception. *Journal of Manufacturing Systems*, *61*, 530-535.

[26] Zhang, J., & Tao, D. (2020). Empowering things with intelligence: a survey of the progress, challenges, and opportunities in artificial intelligence of things. *IEEE Internet of Things Journal*, *8*(10), 7789-7817.

[27] Zhang, Q., Abdullah, A. R., Chong, C. W., & Ali, M. H. (2022). E-Commerce Information System Management Based on Data Mining and Neural Network Algorithms. *Computational Intelligence and Neuroscience*, *2022*(1), 1499801. https://doi.org/10.1155/2022/1499801