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Asst. Prof. Dr. Özerk YAVUZ

<https://orcid.org/0000-0002-1371-688X>

Nişantaşı University, Faculty of Economics, Administrative and Social Sciences, Management Information Systems Department, Istanbul, TURKEY

ANTECEDENTS OF ONLINE PURCHASING BEHAVIOR FOR PRODUCTS MARKETING IN CONTEMPORARY WORLD: AN INTEGRATED APPROACH WITH DEEP LEARNING, MACHINE LEARNING AND DATA MINING

ÇAĞDAŞ DÜNYADA ÜRÜN PAZARLAMASI İÇİN ÇEVİRİMİÇİ SATIN ALMA DAVRANIŞININ ÖNCÜLLERİ: DERİN ÖĞRENME, MAKİNE ÖĞRENİMİ VE VERİ MADENCİLİĞİ İLE ENTEGRE BİR YAKLAŞIM

ABSTRACT

In the last decade as a result of the developments in Information systems and information technologies, payment systems, structural reforms implemented in several geographies and regions, new retail and commerce approaches evolved and entered into our lives. Today many consumers prefer online commerce and retail options, whereas some think of switching to online channels because of their popularity and distinct advantages it provides. On the other hand number of consumers using traditional sales channels remains important. In this research some of the characteristics and antecedents of online purchasing behavior, which is known to be one of the consumer behavior types, are analyzed with the help of deep learning, supervised and unsupervised machine learning forms of data mining. Some predictive rules discovered as part of the analysis process with the performance evaluations.

Keywords: Online Marketing, Online Commerce, Online Retail, Clustering, Classification, Data Mining, Machine Learning, Quantitative Analysis, Supervised Learning, Unsupervised Learning.

ÖZET

Son on yılda Bilgi sistemleri ve bilgi teknolojilerinde yaşanan gelişmeler, ödeme sistemleri, çeşitli coğrafya ve bölgelerde uygulanan yapısal reformlar sonucunda yeni perakende ve ticaret anlayışları evrilerek hayatımıza girmiştir. Günümüzde birçok tüketici çevrimiçi ticaret ve perakende seçeneklerini tercih ederken, bazıları popülerliği ve sağladığı farklı avantajlar nedeniyle çevrimiçi kanallara geçmeyi düşünmektedir. Öte yandan geleneksel satış kanallarını kullanan tüketici sayısı önemini korumaktadır. Bu çalışmada, tüketici davranış türlerinden biri olarak bilinen çevrimiçi satın alma davranışının bazı özellikleri ve öncülleri, veri madenciliğinin derin öğrenme, denetimli ve denetimsiz makine öğrenmesi biçimleri yardımıyla analiz edilmiş, bu algoritmaların performans değerlendirmeleri

ile bazı kestirimsel ve tahminsel kurallar paylaşılmıştır

Anahtar Kelimeler: Online Pazarlama, Online Ticaret, Online Perakendecilik, Kümeleme, Sınıflandırma, Veri Madenciliği, Makine Öğrenimi, Kantitatif Analiz, Denetimli Öğrenme, Denetimsiz Öğrenme.

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1. INTRODUCTION

In the last decade as a result of the developments in Information systems and information technologies, payment systems, structural reforms implemented in several geographies and regions, new retail and commerce approaches evolved and entered into our lives. Today many consumers prefer online commerce and retail options, whereas some think of switching to online channels because of their popularity and distinct advantages it provides. On the other hand number of consumers using traditional sales channels remains important. In this research, some of the characteristics and antecedents of online purchasing behavior, which is known to be one of the consumer behavior types, are analyzed with the help of supervised and unsupervised machine learning forms of data mining. Some predictive rules were discovered as part of the analysis process with the performance evaluations of the algorithms shared and discussed (Kotler, 1991; Kotler, 2000; Malhotra, 2007)

With the changes in the business landscape, evolutions in information technology, information systems, payment systems, globalization, engineering solutions, new forms of retail, commerce and marketing approaches evolved over time. As a result, many consumers turned to online venues for satisfying their needs. With the applications and systems developed brands and organizations found presence in online spaces in the whole customer decision-making process composed of needs recognition, information search, and gathering, alternatives evaluation, assessment, purchase decision and post-purchase evaluation. As a result, a significant portion of the sales transactions has started to be made online (Kotler, 1991; Kotler, 2000; Malhotra, 2007).

In managing and formulizing marketing strategies, plans, and programs for online venues classical marketing approaches, functions with the right positioning strategies composed of the right marketing mix elements as product, price, place, promotion preserve its importance whereas new approaches and trends also found a place in the marketing scientific body of knowledge terminology. Action to call, search engine optimization, use of the internet of things, or conventional data gathering techniques driven by customer data warehouses and big data for predictive knowledge are some of the trends and contemporary approaches found in our lives (Kotler, 1991; Kotler, 2000; Malhotra, 2007).

As indicated by many notable scholars and studies in literature, one of the best marketing strategies remains to be understanding the customer, being customer centric and satisfying the customer which would lead to a long-term profitable relationship, more sales revenues, more customer lifetime value, a good customer portfolio and a good market share both locally and globally. Thinking global, acting local strategies strengthened with multicultural awareness may provide several advantages and a competitive edge to the organizations in this context. In order to be successful in the marketplace, an integrated marketing approach composed of products that have a competitive edge with the right price should be provided to the customer using the right sales channels strengthened with the right communication strategies composed of public relations and advertisements in online or traditional spaces and venues. Also in order to serve the respected market segments and build a positive image in the minds of the customer, the right segmentation, targeting, and positioning strategies should be applied (Kotler, 1991; Kotler, 2000; Malhotra, 2007).

In this context whole value chain composed of inbound logistics, output logistics and different functions of the organization should holistically be aligned with the aim of providing superior value to the customers with the products and services that have core competencies and distinctive edge. In providing these goods and services qualified personnel should be attracted and acquired which would score in the marketplace with the talents that they have in developing cutting edge products and services. Planning, leading, organizing and controlling functions as noted by several scholars in literature should be employed in managing all resources in the value chain in this customer centric journey. Products can be defined as the form of any type of tangible object that can be delivered and supplied to the consumer to satisfy his/ her needs. Understanding several consumer characteristics in product preference in online and contemporary sales channels may provide several insights in this context (Kotler, 1991; Kotler, 2000; Malhotra, 2007).

Similar to several behavioral forms that humans engage in, when online purchasing behavior is analyzed and investigated, some antecedents and factors that have influenced that behavior to occur are analyzed and tried to be understood by behavioral theorists and consumer behaviorists. As suggested in literature its believed that people engage in behaviors that are likely to produce good outcomes and rewards, whereas distracting behaviors that may have negative consequences or risks. In this context several factors as subjective norms, group norms, past behavior, social identity, personality characteristics, positive word of mouth behavior, opinion leaders, reference groups, in group behavior, out group behavior factors, perceived easiness, perceived usefulness of technology acceptance model, attitude towards behavior, intention to that behavior, trust, outcome expectations and anticipated emotions may have influential factors in online purchasing behavior to occur with all other personality characteristics of the consumer and marketing mix elements. In this research, some of these factors have been analyzed with the aim of providing exploratory and confirmatory understanding for such phenomena and understanding some of the factors associated with such behavior to occur. In this context, a scientific, quantitative research methodology is applied composed of contemporary machine learning and data mining approaches in the literature.

2. RESEARCH METHOD

In this study, a quantitative research paradigm has been employed. Quantitative research paradigms aim to explore the phenomena by applying deductive techniques. They have a positivistic and objectivist orientation of epistemology and ontology. Quantitative data is a type of structured knowledge that can be collected by several approaches in the form of primary data sources and secondary data sources. Conventional and unconventional forms of data gathering techniques can be applied as, sensor, user, service driven data collection or gathering, internet of things, paper administered surveys, online surveys, etc. (Yavuz, 2021a; Yavuz, 2021b; Yavuz, 2021c; Yavuz, 2022a; Yavuz, 2022b; Yavuz, 2022c; Yavuz, 2022d; Yavuz, 2022e).

Data mining is defined as a methodological approach in quantitative data analysis as indicated in the literature. The data mining process is composed of some set of structured steps that makes the data mining research process and methodology. Initially, understanding and analysis of the situation and business problem is completed which is followed by the examination and pre-processing of data. Later a conceptual framework or model is devised following the literature review and analysis approaches. Testing of the model with supervised and unsupervised versions of machine learning approaches takes place. Finally predicted analysis results are evaluated and assessed (Yavuz, 2021a; Yavuz, 2021b; Yavuz, 2021c; Yavuz, 2022a; Yavuz, 2022b; Yavuz, 2022c; Yavuz, 2022d; Yavuz, 2022e).

The data mining approach can be considered as a systematical, structured research process that focuses on situation analysis, data gathering, model formation, and testing of the model. Later findings and knowledge discovered from these analyses can be used as a decision support point for leaders, the science community, and society at large. The machine learning technique which is a famous approach in data mining-based quantitative research methodologies is a form of learning in machine forms. This learning process is usually triggered and activated by forwarding feeding approaches which are later followed with backpropagation processes which are stochastic in nature. With the help of mapping functions, input layers in the model are mapped to the output layer considering the independent, dependent values. Functions and equations involved in this mapping are calculated. Later in many forms rules generated with the least error rate and which provides the most proximity to actual results are selected and presented as the distinctive association rules. In the evaluation of this, a stochastic backpropagation technique is used in many cases. Supervised learning and unsupervised learning are two forms of machine learning in data mining. Supervised learning is a form of classification approach where input and output layer mappings are done with the transformation functions, with the aim of rule discovery and insights discovery. A stochastic backpropagation technique is used in this type of machine learning in general. In the mapping process, independent multivariate variables are assigned to the respective class labels which are considered as the dependent variables in the output layer. Since the initial labeling of the dependent values is in the form of the nominal values technique, this type of machine learning is named supervised machine learning. On the other hand in unsupervised machine learning, several attributes of different instances are assigned to respective clusters with respective values without the requirement of an initial class label declaration. In this form of machine learning several mathematical and statistical functions utilizing heuristics in many cases are applied. In most of the clustering analysis which is also known as unsupervised machine learning centroid values for each independent cluster is calculated and related attribute values for several instances in the data set are

assigned to the cluster with the focus on similarity and convergence maximization in one cluster and divergence, difference maximization with other cluster members having other centroid values. In deep learning which is a form of machine learning, feature extraction and classification is integrated into labeling the association rules. In contrast to traditional machine learning algorithms, in deep learning new associations and features are formed and discovered based on early input values in the latent neurons which are followed with a classification approach in an integrated way. Following the feature extraction and classification steps association rules are assigned to the respective class labels in the model training later the model is tested as in the conventional machine learning approaches. Deep learning can be in the form of supervised, unsupervised, or semi-supervised fashion. Multilayer Perceptron, Bayesian Networks, D14jMlpClassifier (Deep Learning), OneR Method, Hoeffding Tree, Random, Tree, Kmeans have been some of the most cited supervised and unsupervised machine learning techniques which utilize different classification and clustering approaches in the literature. Machine learning utilization of data mining can provide an exploratory and confirmatory understanding of the phenomena in question and may provide insights and in-depth understanding with knowledge discovery, prediction, or forecasting options it provides. In this context, a data mining approach strengthened with deep learning techniques has been employed to understand phenomena (Yavuz, 2021a; Yavuz, 2021b; Yavuz, 2021c; Yavuz, 2022a; Yavuz, 2022b; Yavuz, 2022c; Yavuz, 2022d; Yavuz, 2022e).

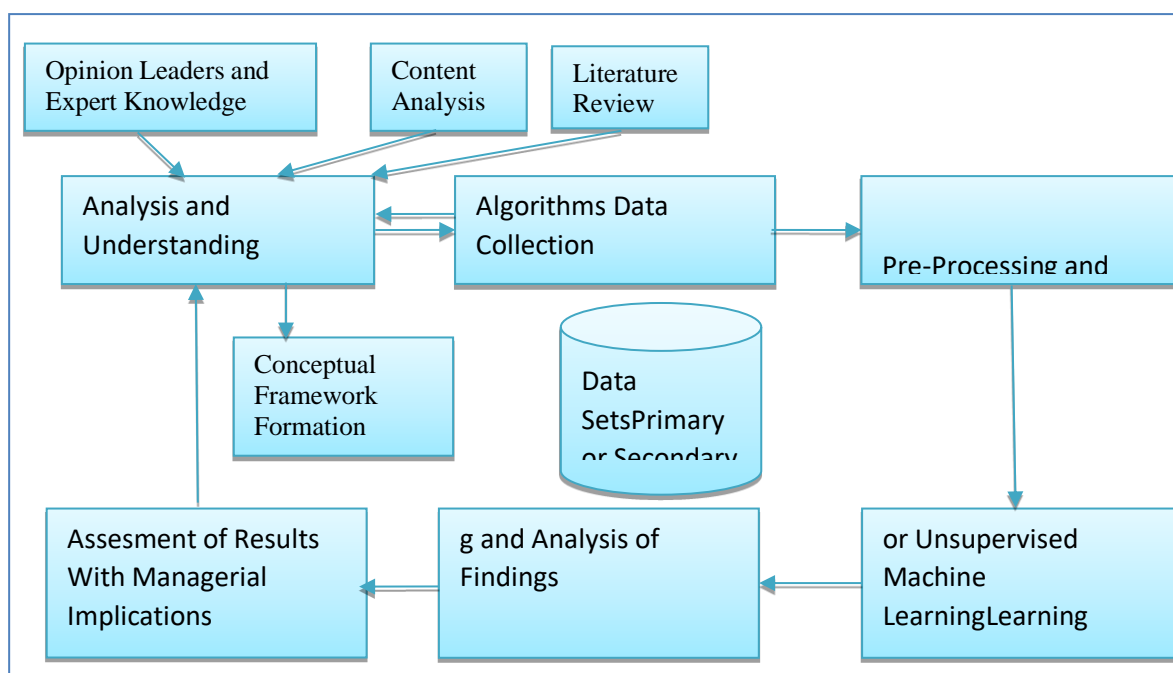


Figure 1. Data Mining Process (Prepared by the Researcher)

The Data Mining methodology followed can be seen in Figure 1. In the analysis section, Multilayer Perceptron, Bayesian Networks, D14jMlpClassifier (Deep Learning), OneR Method, Hoeffding Tree, Random, Tree, Kmeans have been used for the machine learning techniques. Unsupervised machine learning algorithms here assess the instance values and assign these independent values to the respective segment clusters whereas supervised machine learning algorithms mainly focus on mapping the multivariate variables in input layers to class labels in output layers with transformation and mapping functions, later applying stochastic backpropagation techniques in many cases. Additionally, class-based metrics are evaluated. Performances of several machine learning approaches have been compared. Rules with rule functions have been generated in a reinforced fashion some applying forward feeding and backpropagation approaches based on the algorithmic designs and architectures they have (Yavuz, 2021a; Yavuz, 2021b; Yavuz, 2021c; Yavuz, 2022a; Yavuz, 2022b; Yavuz, 2022c; Yavuz, 2022d; Yavuz, 2022e). Based on several factors such as algorithmic design, algorithmic architecture, the complexity of the algorithms these algorithms can generate different results for similar, same, or distinct problem sets and domains (Yavuz, 2021a; Yavuz, 2021b; Yavuz, 2021c; Yavuz, 2022a; Yavuz, 2022b; Yavuz, 2022c; Yavuz, 2022d; Yavuz, 2022e). By using the same data set with the same parameter values, performance indicators of the algorithms have been assessed and evaluated. The top scorer algorithm for this problem domain with a respective data set and parameters has been discovered with the analysis conducted. Knowledge patterns and rules found out have been interpreted and listed.

Unsupervised and supervised machine learning methodologies followed are seen in Figure 2 and Figure 3.

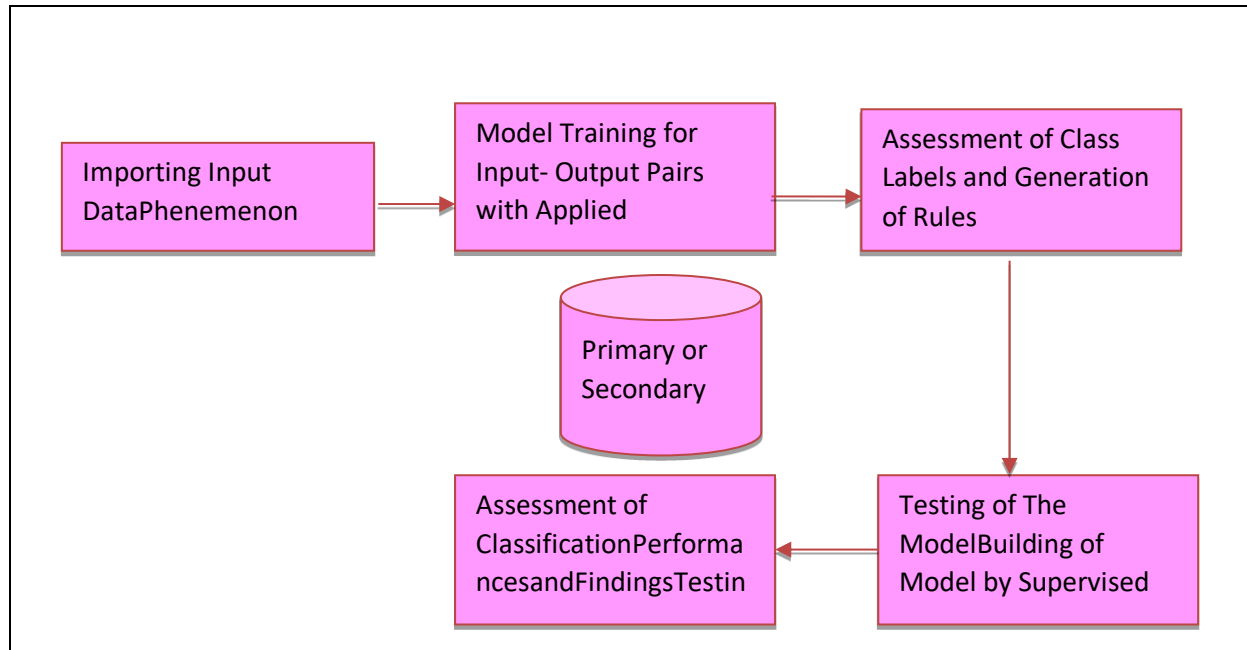


Figure 2. Supervised Machine Learning Process(Prepared by the Researcher)

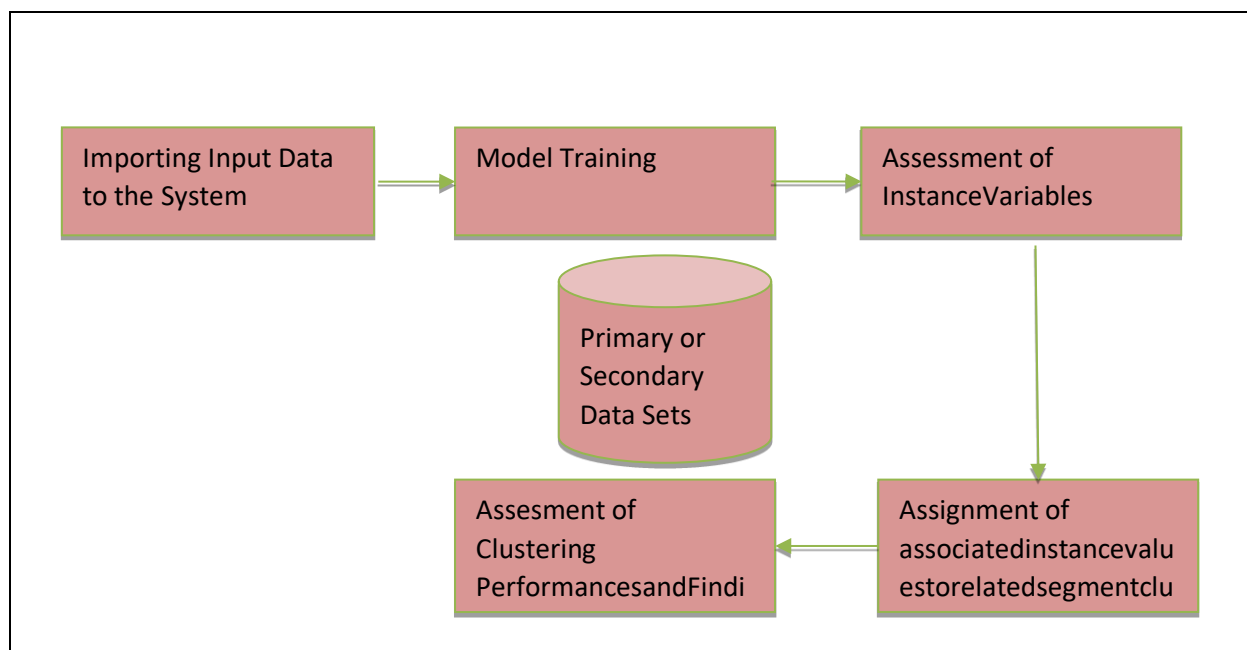


Figure 3. Unsupervised Machine Learning Process Composed of Model Building and Testing(Prepared by the Researcher)

The data analysis and online administered survey have been conducted with a snowball sampling approach in the city of Istanbul, Turkey (Yavuz, 2021a; Yavuz, 2021b; Yavuz, 2021c; Yavuz, 2022a; Yavuz, 2022b; Yavuz, 2022c; Yavuz, 2022d; Yavuz, 2022e).

Table 1. List of Attributes

Price Sensitivity Indicator	Numeric
Product Feature Sensitivity Indicator	Numeric
Channel Sensitivity Indicator	Numeric
Advertisement Sensitivity Indicator	Numeric
Public Relations Sensitivity Indicator	Numeric
Celebrity Endorsement Sensitivity Indicator	Numeric
Sex Appeal Sensitivity Indicator	Numeric
Brand Value Sensitivity Indicator	Numeric
Online Purchase Behavior	Nominal
Age	Nominal
Gender	Nominal
Marital Status	Nominal

In data mining analysis, association rules, knowledge, and understandings are discovered with the help of classification and clustering algorithms for the relevant problem set and domain. In these approaches, input-output mapping functions are used to create association rules that map the outer layer to the inner layer. In some, feedforward and backpropagation techniques have been applied. The relevant rules with the least error rate are presented as the main rules of the analysis (Yavuz, 2013; Yavuz, 2018; Yavuz, 2021a; Yavuz, 2021b; Yavuz, 2021c; Yavuz, 2022a; Yavuz, 2022b; Yavuz, 2022c; Yavuz, 2022d; Yavuz, 2022e).

As Özerk claims, many data mining processes today apply a technical approach in supervised learning where independent or multivariate indicators and variables are assigned to output class labels using functions of mapping. In unsupervised versions of data mining and machine learning, the core values of each cluster (centroids) are calculated, the corresponding sample and attribute values are assigned to the respective clusters so as to maximize convergence and minimize differences

in the same cluster, whereas divergence is expected with the members of different clusters. In the process of supervised and unsupervised machine learning, rules are created to improve the exploratory and confirmatory understanding of the phenomenon (Yavuz, 2013; Yavuz, 2018; Yavuz, 2021a; Yavuz, 2021b; Yavuz, 2021c; Yavuz, 2022a; Yavuz, 2022b; Yavuz, 2022c; Yavuz, 2022d; Yavuz, 2022e). In this context, an Aristotelian research design path can bring several advantages in understanding these phenomena and can be a good decision support tool for key business leaders, political leaders, and society in general (Yavuz, 2013; Yavuz, 2018; Yavuz, 2021a; Yavuz, 2021b; Yavuz, 2021c; Yavuz, 2022a; Yavuz, 2022b; Yavuz, 2022c; Yavuz, 2022d; Yavuz, 2022e).

The same input load with the same parameters was tested using machine learning algorithms, Multilayer Perceptron, Bayesian Networks, D14jMlpClassifier (Deep Learning), OneR Method, Hoeffding Tree, Random, Tree, Kmeans. The University of Waikato's Weka data mining package, which includes supervised and unsupervised machine learning applications, was used in the analysis. Then, the performance of classification and clustering was compared and evaluated. In the analysis, 10-fold cross validation method has been used to train and test the model. Based on the performance indicators associated with the data mining analysis, a high-performance algorithm was chosen and can be used for such areas and sets of problems to gain additional insight and insight. For this purpose, values of mean squared error, precision, correct classification rate, and misclassification rate were used (Yavuz, 2013; Yavuz, 2018; Yavuz, 2021a; Yavuz, 2021b; Yavuz, 2021c; Yavuz, 2022a; Yavuz, 2022b; Yavuz, 2022c; Yavuz, 2022d; Yavuz, 2022e). The analysis revealed the performance indicator values and rules as in Tables 2 and 3.

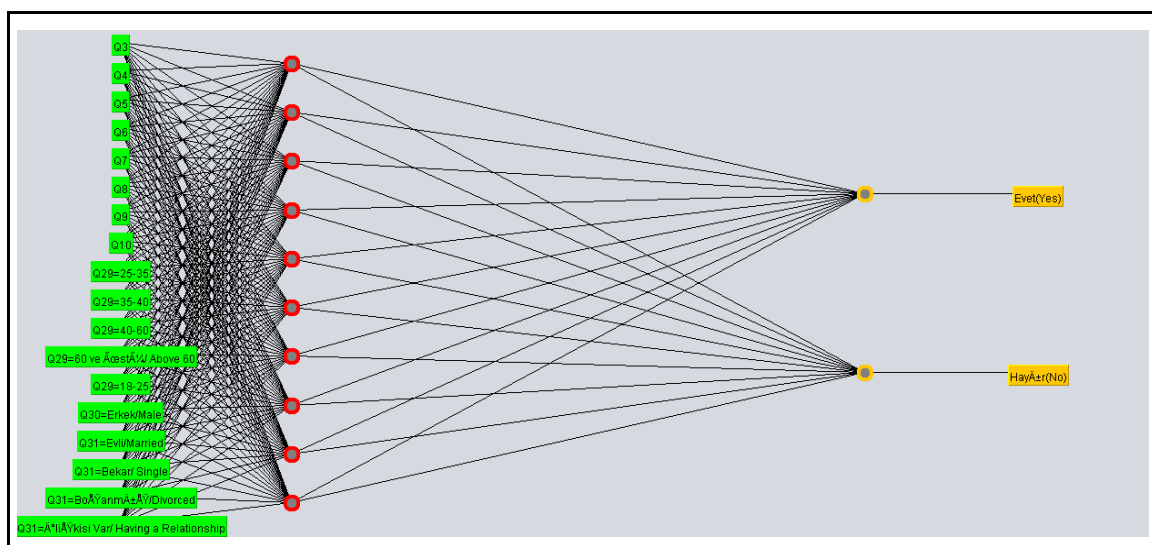
Table 2. Performance Scores of Machine Learning Algorithms

Method Applied	Multilayer Perceptron	Bayesian Networks	D14jMlpClassifier (Deep Learning)	OneR Method	Hoeffding Tree	Random Tree
RMSE	0.23	0.26	0.49	0.21	0.22	0.23
Correctly Classified %	95.55	93.33	62.22	95.55	95.55	95.55
Incorrectly Classified %	4.44	6.66	37.77	4.44	4.44	4.44

Table 3. Association Rules Generated by Supervised and Unsupervised Machine Learning Algorithms

The analysis results revealed that price is an important criterion in buying a product for all consumer groups.
Females in the age range of 18-25 were found to include the customer segments with the most price centric and least price centric group
Females in the age range of 25-35 are the customer segment that gives importance to product functions and functionalities
Females in the age range of 18-25 are the customer segment that gives importance to the sales channels
Females in the age range of 18-25 are the group that gives importance to advertisements most whereas the customer segment with females in the age range of 25-35 is the least advertisement sensitive segment
Customers in the age range of 18-25 are the group that gives importance to public relations most whereas the customer segment in the age range of 25-35 is the least public relations sensitive segment
Celebrity endorsement is most favored with the customer segment in the age range of 18-25
The use of sex-appeal in the advertising themes of a product is mostly favored by customer groups with single, females in the age range of 18-25 whereas the least sensitive customer segment for this category is married, female customers in the age range of 25-35 which is followed with the segment composed of married, male customers in the age range of 40-60
Product value has been a significant predictor in all consumer segments where 18-25 age range found to be the top scorer for this category
For all ages, education, marital status, and gender groups online purchasing behavior occurs
If given sex appeal importance status is smaller than 1.5 then online purchasing behavior is true, if given sex appeal status it is greater than 1.5 and brand value is smaller than 2.5 purchasing behavior is false
If given importance to having famous faces in the advertisements of a product is less than 2.5 out of 5 then online purchasing behavior is false
If given importance to having famous faces in the advertisements of a product is greater than or equal to 2.5 then online purchasing behavior is true

The analysis results revealed that price is an important criterion in buying a product for all consumer groups. Females in the age range of 18-25 were found to include the customer segments with the most price centric and least price centric group. Females in the age range of 25-35 are the customer segment that gives importance to product functions and functionalities. Females in the age range of 18-25 are the customer segment that gives importance to the sales channels. Females in the age range of 18-25 are the group that gives importance to advertisements most whereas the customer segment with females in the age range of 25-35 is the least advertisement sensitive segment. Customers in the age range of 18-25 are the group that gives importance to public relations most whereas the customer segment in the age range of 25-35 is the least public relations sensitive segment. Celebrity endorsement is most favored with the customer segment in the age range of 18-25. The use of sex-appeal in the advertising themes of a product is mostly favored by customer groups with single, females in the age range of 18-25 whereas the least sensitive customer segment for this category is married, female customers in the age range of 25-35 which is followed with the segment composed of married, male customers in the age range of 40-60. Product value has been a significant predictor in all consumer segments where 18-25 age range found to be the top scorer for this category. For all ages, education, marital status, and gender groups online purchasing behavior occurs. If given sex appeal importance status is smaller than 1.5 then online purchasing behavior is true, if given sex appeal status it is greater than 1.5 and brand value is smaller than 2.5 purchasing behavior is false. If given importance to having famous faces in the advertisements of a product is less than 2.5 out of 5 then online purchasing behavior is false. If given importance to having famous faces in the advertisements of a product is greater than or equal to 2.5 then online purchasing behavior is true.

**Figure 4.** A Neural Network View of the Model Generated (Multi-Layer Perceptron- Online Purchase Behavior is the dependent variable)

In the analysis OneR method has been the top-performing algorithm with an RMSE of 0.21, correct classification of 95.55, and an incorrect classification rate of 4.44 among other supervised machine learning approaches applied. To sum up, supervised and unsupervised machine learning algorithms, which are also known as classification and clustering techniques in data mining literature can be used as an effective and efficient tool for knowledge discovery or confirmation in exploratory and confirmatory research designs. These insights may be considered by decision-makers and society at large in such problem sets and domains. Based on the input loads, algorithmic design, architecture, and performance of the algorithm which can be assessed with approximations, metrics as Big O or Big Ω are used to assess the efficiency and the computational complexity (Yavuz, 2013; Yavuz, 2018; Yavuz, 2021a; Yavuz, 2021b; Yavuz, 2021c; Yavuz, 2022a; Yavuz, 2022b; Yavuz, 2022c; Yavuz, 2022d; Yavuz, 2022e).

3. DISCUSSION and CONCLUSION

In the last decade as a result of the developments in Information systems and information technologies, payment systems, structural reforms implemented in several geographies and regions, new retail and commerce approaches evolved and entered into our lives. Today many consumers prefer online commerce and retail options, whereas some think on switching to online channels because of its popularity and distinct advantages it provides. On the other hand number of consumers using traditional sales channels remains important.

As seen in several behavioral forms, when online purchasing behavior is analyzed and investigated, some antecedents and factors that have influence that behavior to occur is analyzed and tried to be understood by behavioral theorists and consumer behaviorists. As suggested in literature its believed that people engage in behaviors that are likely to produce good outcomes and rewards, whereas distract behaviors that may have negative consequences or risks. In this context several factors as subjective norms, group norms, past behavior, social identity, personality characteristics, positive word of mouth behavior, opinion leaders, reference groups, in group behavior, out group behavior factors, perceived easiness, perceived usefulness of technology acceptance model, attitude towards behavior, intention to that behavior, trust, outcome expectations and anticipated emotions may have influential factors in online purchasing behavior to occur with all other personality characteristics of the consumer and marketing mix elements.

In the analysis all the variables have been assessed in the form of independent-dependent relations form as in cause and effect forms. Some of the leading indicators of online purchasing behavior with association rules discovered have been examined consequently. Among all the machine learning algorithms applied OneR method has been the top scorer for the same input load and parameters which can be used to enhance exploratory and confirmatory understanding in such phenomena which may provide insights to leaders, research community and members of the society.

REFERENCES

- Karahoca, D., Karahoca, A. & Yavuz, Ö. (2013). An Early Warning System Approach for the Identification of Currency Crises with Data Mining Techniques. *Neural Computing and Applications*, 23(7-8), 2471-2479.
- Kotler, P. (1991). *Principles of Marketing*. Englewood Cliffs –Prentice Hall, New Jersey (US).
- Kotler, P. (2000). *Marketing Management*. Upper Saddle River –Prentice Hall, New Jersey (US).
- Malhotra, N. K. (2007). *Marketing Research: An Applied Orientation*. Upper Saddle River-Pearson/Prentice Hall, New Jersey (US).
- Yavuz, Ö. (2009). *An Early Warning System Approach for the Identification of Currency Crises*. Master Thesis, Bahcesehir University Graduate School of Sciences, Istanbul.
- Yavuz, Ö. (2018). *Marketing Implications of Participative Behavior in Virtual Communities*. Doctoral Thesis, Bahcesehir University Graduate School of Social Sciences, Istanbul.
- Yavuz, Ö. (2021a). *A Data Mining Analysis of Coronavirus Cases and Vaccinations in The City of London*, Ankara: Astana Publisher.

- Yavuz, Ö. (2021b). A Public Perceptions Analysis with Data Mining Algorithms. 2. International “Başkent” Congress on Physical, Social and Health Sciences, 25-26 September – Ankara, pp.69-73.
- Yavuz, Ö. (2021c). A Leading Indicator Approach with Data Mining Techniques in Analysing Bitcoin Market Value. *European Journal of Science and Technology*, 32, 20-26.
- Yavuz, Ö. (2022a). An Optimization Focused Machine Learning Approach in Analysing Arts Participative Behavior with Fine Arts Education Considerations. *International Scientific and Vocational Studies Journal*, 5(2), 241-253.
- Yavuz, Ö. (2022b). A 21st Century Approach in Analysing Health Precautions in London with Machine Learning Driven Data Mining. *European Journal of Science and Technology*, 32, 101-106.
- Yavuz, Ö. (2022c). Nitel ve Nicel Araştırma Tasarımı Uygulamasıyla Etanol Kullanımını ve Etkilerinin Anlaşılması. *European Journal of Science and Technology*, 32, 40-49.
- Yavuz, Ö. (2022d). A Classification and Clustering Approach Using Data Mining Techniques in Analysing Gastrointestinal Tract. *International Scientific and Vocational Studies Journal*, 5(2), 254-265.
- Yavuz, Ö. (2022e). *Engineering & architectural Science - 2 (A Multidisciplinary Approach)*.
- Yavuz, Ö., Karahoca, A. and Karahoca, D. (2019). A Data Mining Approach for Desire and Intention to Participate in Virtual Communities. *International Journal of Electrical and Computer Engineering*, 9(5), 3714-3719.