

Comparison of the State-of-art Big Data Analysis and Conventional Prediction for Consumer Behavior

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Abstract. Big data analysis is a reflection of the transformation of ways to receive information via the Internet. It also affects consumer behavior analysis, which varies from conventional consumer behavior models. This paper summarizes the development of consumer behavior models and compares consumer behavior models based on big data analysis with traditional consumer behavior prediction models. The advantages and disadvantages of them are discussed and relevant suggestions for big data analysis are raised. According to the analysis, the application of big data analysis on consumer behavior shows its superiority in efficiency, sample size and supportive database. Additionally, it successfully adapts to the transformation of the era of information. Consumer behavior models in the current society are more associated with big data analysis and consumption ability of residents. It is valuable to give an overview of what big data has brought to consumer behavior study, how consumption ability has increased in the context of big data, so as to stimulate the growth of consumer behavior study.

Keywords: Big data analysis; Consumer behavior analysis; Consumer behavior model; Machine learning; Data mining.

1. Introduction

Consumer behavior is referred to as a decision-making process to allocate individuals' resources to spend on various services and products. Actions that have been taken by individuals and psychological and social processes are considered to be included in the study of consumer behavior. Consumer behavior is also defined by Schiffan and Kanuk, conveying the idea that necessary acts involving finding, comparing, using, and evaluating different products and services to fulfill people's needs are suggested as consumer behavior [1]. It is highly associated with marketing science and economic psychology, leading to the emergence of methodological and philosophical questions [2]. After the end of World War II, the demand for civilian goods increased sharply, while declined for military goods. Besides, the thing pursued by mankind has changed according to this situation [3]. Enterprises began to adjust their marketing guidelines and put more emphasis on customers to adapt to this huge transformation. In the 1960s, consumer behavior is described to be an independent research field, studied in two forms, the positivist, and the non-positivist [4]. Traditional models consist of the economic model, learning model, psychological and sociological model. In addition, some new models are added to improve consumer behavior models such as the Stimulus-Response model and the Howard-Sheth model. In the 2000s, with the development of economic mathematics, computer science, the Internet, and different mobile terminals, a large number of consumers relied on the network to help their work and life. Thus, enterprises can have the access to their network traces to analyze their consumer behavior.

Consumer behavior is based on fundamental theories. Expected and marginal utility stated by Daniel Bernoulli in 1783 and Theory of Games and Economic Behavior demonstrated by John and Oskar in 1944 have supported the development of traditional models of consumer behavior. The economic model refers to predicting by measuring economic figures and indicators. At the same time, the learning model suggests that consumer choice is determined by fundamental and learned demand. These two models have played an important role in analyzing consumer behavior in the past years based on previous elegant and fundamental theoretical frameworks [1]. The research focus has shifted to psychological entities, aiming to figure out why individuals buy after the end of World War II. During this period, Sigmund has contributed to introducing the behavior theory to marketing,

resulting in a combination of marketing and consumer behavior [5]. The psychological model has noticed that the existence of the conscious and subconscious mind. Afterward, Lewin indicated the influence of social psychology on consumer behavior, guiding the conceptualization of consumer behavior in the current society [5]. Another traditional model is called the social model, focusing on the impact of social roles of individuals on consumer behavior [1]. The middle range theories helped explain further some limited research fields [5]. In the 1970s, Rosenberg and Fishbein raised the expectancy-value theories, indicating consumer researchers are more attracted to attitude change and formation. The extended attitude-behavior model stated by Fishbein began to be in the mainstream in the next few years [5]. These models are useful for extending different dimensions to stimulate the research on consumer behavior in relevant fields, enriching various perspectives to analyze behavior. Research in the late 20th century became more complex and less descriptive than it had been earlier. When it comes to the 21st century, progress in technology has brought new sources to analyze consumer behavior in a new perspective. Data mining techniques [6], input-process-output model, and AISAS model [7] are raised, adapting the changing market for analyzing the consumer behavior. Some analytical categories such as reinforcement patterns, effectively enhance the complementarity of products in the same categories and accept the market research outcomes to improve the insights to support the development of behavioral economics [8].

The current society is closely associated with the Internet and people's consuming habits can be affected by the Internet. Although previous papers offer a comprehensive view of prediction models for consumer behavior, combining big data analysis and conventional prediction models to give an overview is still needed to be investigated. With the aim of adaption to the changing environment of big data, seeking further research on new consumer behavior models through big data analysis is of great importance. Based on the big data, corresponding marketing strategies may vary according to the accurate traces and observed characteristics of different groups of people. In order to consider the most suitable ways to predict customers' behavior, it is valuable to figure out the differences between conventional ways and big data analysis. This paper will firstly introduce some independent variables and dependent variables involved in consumer behavior analysis. Subsequently, conventional prediction models and machine learning analytical methods based on big data analysis will be illustrated and evaluated respectively. In addition, comparisons between these two perspectives will be made to discuss their advantages and weaknesses. Then, it comes to limitations and future development suggestions, giving some insights to make relevant research theories more solidary. Finally, the whole comparison process will be concluded.

2. Independent and dependent variables in consumer behavior analysis

There are several factors including cultural factors, psychological factors, social factors, and personal factors that may influence the corresponding consuming behavior.

2.1 Cultural factors

With regards to cultural factors, variables can be divided into three different factors which refer to culture, subculture, and social class [9]. In the first place, culture is considered to drive personal needs and attitudes towards kinds of products and services. This is because that different groups of people grow in various societies may perceive distinctive basic values. Secondly, according to Kotler & Armstrong, people from different countries, regions, religions racial groups may have specific demand which is limited in this specific group [10]. This is how subculture plays its role in the procedure of selling products and service. The third point is called social class. Individuals from various classes in a certain society vary from each group, showing abundant consumption patterns and leisure interests. Targets on these groups should also be changed based on the specific conditions.

2.2 Psychological factors

Psychological factors can be expressed as four main independent variables, motivation, perception, beliefs and attitudes, and learning. As for motivation, subconscious motives or motives may potentially lead individuals to make consumption decisions with the aim of fulfilling their needs in a certain period. Motives usually appear in most cases, and they are endless, continuing to attract individuals to buy to satisfy individuals themselves. Additionally, when people deal with lots of information, it is unavoidable to involve three procedures, selective attention, selective distortion, as well as selective retention. The first process is about explaining and understanding received information in a way they trust and are familiar with. The second tends to convey that efforts should be made by marketing to closely relate to consumers' minds and beliefs [1, 9]. People always rely on what they are taught and intend to support their beliefs. Attitude is also another related factor, reflecting their feelings and comments on some goods. This phenomenon is more associated with what they have learned in the previous time periods and the opinions they accepted. Determining whether to buy a certain product or not have a direct relationship with customers' attitudes and beliefs. Another independent variable is learning, which is described as people's reactions to cues that may be the stimulus to influence consumption conditions.

2.3 Social factors

Social factors consist of groups, family, roles and status. Groups can have an impact on people's behavior and attitudes indirectly or directly, then, their changing behavior and attitudes will affect their consumption choices. Secondly, most people have a close relationship with their families during their whole life. Members of the family strongly influence each other in a potential way. For instance, children's willingness largely decides what parents will buy when children are growing [9]. Roles and status also attach great importance to impacting consumer behavior. This factor is referred to one's position in a specific group such as family and organizations. The intangible responsibilities are given to individuals, potentially making them make the most appropriate consumption choice.

2.4 Personal factors

Occupation, age, lifestyle, personality, and economic situation have constructed the structure for personal factors independent variables. Firstly, people prefer buying suitable goods for the requirement of their jobs. To be specific, it is obvious that workers are less interested in consuming a lot of business suits compared with managers in enterprises [1]. Moreover, human beings are influenced by the stages in their life cycle. For instance, people who are married and young children may prefer different types of clothes [9]. The economic level will also decide the willingness of a consumer to buy goods. If they hold a positive attitude to their income and savings, they may try to find goods that fit their purchase power best. The last independent variable is the lifestyle. Lifestyle can be various, and it is significant for helping analyze consumer behavior. For example, people who care more about the environment may spend more budget on environmentally friendly goods compared to others.

3. Conventional prediction for consumer behavior analysis

Conventional prediction is referred to as analysis guided by regression and correlation analysis according to equations. The whole process may include looking for factors that influence the research targets, describing its degree of influence, and studying the closeness of the relationship between the variables. For instance, Nisco and Oduro have conducted research to find out the impact of partitioned country-of-origin on consumer behavior. It investigates the effect of country branding, design, parts, and manufacturers on purchase willingness and goods evaluation [11]. They have designed a quantitative analysis, trying to avoid heterogeneity, and improving sampling techniques, data collections and research design to make some progress on the regression analysis [11]. Traditional consumer behavior models have provided theoretic foundations for the construction of regression and

correlation analysis. The AIDMA model is one of the most significant consumer behavior models in the last century, which is developed from the AIDA model [12]. The AIDMA model is shown in Fig. 1. There are five stages in the AIDMA model, that is, attention, interest, desire, memory, and action. It is a principle that describes the dynamic guide for the consumer's psychological process to generate actions after receiving information, as well as the patterning of its sequence.

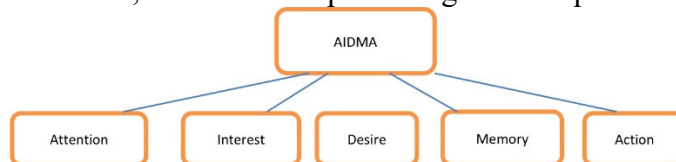


Fig. 1 The AIDMA model [12].

Contemporarily, the conventional prediction method based on constructing equations to conduct correlation analysis and regression analysis have been effective in the research on consumer behavior. In addition to studies of exploratory nature and limited to status representations, this model has extended the system of practical operation for analyzing consumer behavior. Nisco and Oduro reviewed 64 empirical analyses, which have done the regression in the same way, proving the wide use of this conventional prediction method [11]. The detailed process of correlation and regression analysis can be reflected in the following examples. To predict the relationship between remanufactured goods and consumer behavior, Yilmaz and Belbag have indicated a logistics regression model, adapting closed-end questions to collect the data and involving 400 local people in Ankara [13]. The logistics regression model can accept and deal with qualitative data. In addition, it is used for the multivariate and the existence of various independent variables. The advantage is that both discrete and continuous data can be analyzed or combined [14]. The questionnaire focused on random sampling, using a five-point Likert scale. As for the primary research, 100 residents were designed to engage in the first step. Then, relevant correlation analyses are conducted. Afterward, 13 hypotheses have been made and a significant level has been calculated. Another example is the study regarding digital commerce and consumer behavior conducted by Koufaris, et al. in 2014, taking advantage of the regression model to examine the significance level. In this study, it has demonstrated an efficient practice for the construction of structural equations when binary variables exist [15].

These examples can prove that consumer research is usually conducted by sampling, where respondents are randomly selected. Meanwhile, data is obtained through either qualitative or quantitative surveys, with the aim of analyzing to support decisions on marketing strategies. Conventional correlation, regression model, and structural equations have provided effective practical methods to deeply study the independent and dependent variables in consumer behavior theory.

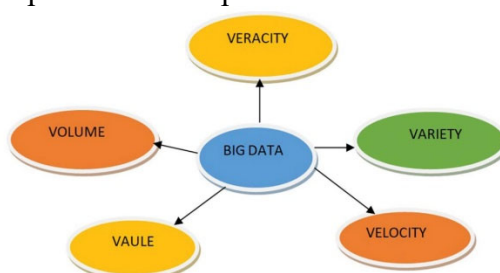


Fig. 2 Features of big data [16].

4. Implementation of big data analysis

With the rapid development of the Internet, the concept of big data analysis has entered the consumer behavior research field. The transformation has demonstrated a new way for consumers to accept information and the need for being capable of understanding the intentions of customers. Features of big data analysis referring to veracity, volume, variety, value, and velocity are listed in Fig. 2. In the current society, consumer research is gradually shifting to the procedure of clustering, mining, and computing the massive data on the Internet and making conclusions and judgments

through the modeling of static data and streaming data [12]. The framework for the working process of big data based on the AISAS model is demonstrated in the Fig. 3. The AISAS model is developed from the AIDMA model, adding elements including search and share. Big data analysis has caused external stimulations by information sorting, big data search, and marketing methodology, influencing internal perception including interest, search, and attention respectively. Afterwards, the change in internal perception leads to consumption decisions which can be also demoted as actions. For the share of buying decisions, building a comprehensive information source for big data to analyze again. This can improve relevant methods to impact consumer behavior the next time.

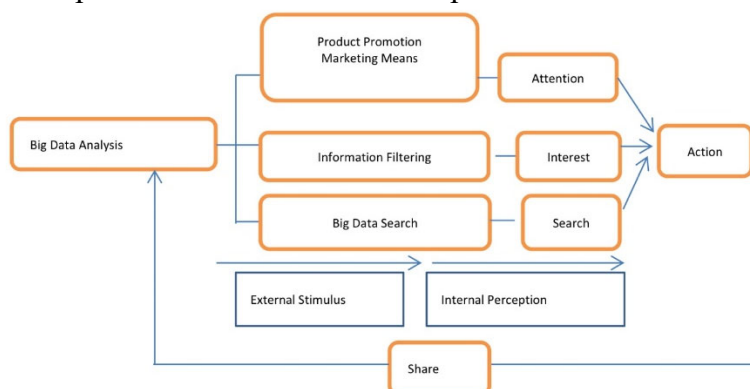


Fig. 3 Big data's impact on consumer behavior analysis based on AISAS model [12]

According to the shifting of the focus, more research has begun to put more emphasis on the construction of the Internet consumer behavior models involving predicting consumer behavior by big data analysis and combine new models with the marketing field. The most valuable advantage is that big data analysis can integrate all kinds of relevant information and summarize the information which has the highest business value for a company. This may involve a process regarding the combination of big data analysis and marketing. More than 90% of the data in this world was generated after the 2010s [17]. At the same time, both mobile applications and social media platforms provide foundations for the generation of data. Then, a portrait of consumers can be established through analysis technology. In this way, it is convenient to set up distinctive marketing strategies for different groups of people. According to static information (e.g., age, gender, job, habits, etc.), dynamic information (e.g., entertainment preferences, health conditions, goods preferences, etc.) and real-time information (e.g., related consumptions, related actions, locations, etc.), various model algorithms and evaluation dimensions can divide consumers into consumer groups in with different attributes by clustering. Relevant marketing strategies will be optimized to check whether it is more cost-saving and efficient to match with appropriate consumer groups and media, achieving a higher conversion rate of target consumer groups. This may include analyzing data about promotional channel types, the contribution level of different channels to websites, and consumers characteristics brought by channels.

The machine learning method is one of the most significant ways to deal with predictions for consumer behavior, which is also widely applied in a variety of business scenarios. This benefits marketing analytics solutions, which are also known as predictive analytics designed to provide techniques to solve marketing problems in society [18]. Support vector machine, written as SVM, is seen as a well-performed algorithm in machine learning to complete the process of consumer behavior prediction. This popular supervised learning model aims to recognize patterns, classify, and run the regression. It does work well with appropriate kernel functions, dealing with high dimensional text classification. In a study on cultivation measures to promote people's ecological consumption, SVM was applied to determine the corresponding classification model for ecological consumer behavior. Among pattern recognition methods, SVM was chosen because of the small sample learning. Then, data was debugged by the principles of SVM. Three different categories of behavior patterns were made after comparing classification accuracy and making use of the Gaussian radial basis kernel function to take the role of the inner product. Thus, targeted measures can be established according

to the categories of ecological consumer behavior in the local area [19]. Compared to SVM, the random forest algorithm performs relatively better in parameter adjustment and operation. Customers' behavior is associated with different parameters. Features and sub-features are caught to allocate their behavior, transforming into various trees with targeted values [20]. Machine learning plays an important role in helping to learn efficient representations of abstraction based on propagation. One of the hardware called the graphics process units can deal with approximately millions of parameters. It is feasible for companies to gather information and predict consumer behavior. For every hour, 2.5 petabytes of data regarding consumer behavior are created by Walmart, which refers to creating 50 million conventional text cabins. Until 2020, the connection between approximately 32 billion goods and computers was estimated to be achieved. Meanwhile, the market size for analyzing and managing big data was evaluated to double every two years [21]. According to the research conducted by Evans Data, it is figured out that the main users of 38.2% of big data analysis applications are people from the consumer service department, marketing department, as well as selling department. Based on this finding, the marketing segment is the most common target group of data analysis, with a proportion of 14.4% [22]. A study on the collection process of opinions of consumers for lavishness hotels through machine learning has demonstrated how the machine learning model has contributed to the design for better management of the brand [23]. The equipment may be connected to the camera in the supermarket, to record the walking trails of customers and give better advice on the location of goods next time. Moreover, in another research regarding a start-up enterprise marketing level, the machine learning model is applied to measure each company's degree of engagement on social media platforms. It has proved the superiority of machine learning in common operation and information analysis [24].

Data mining technique is expected to be an effective tool in the era of big data, catering to the needs for applying to business models. This technique is adapted to collect valuable information to analyze from different dimensions in the backend processers. Business readers can understand the data based on descriptive analytics. Prediction analysis gradually becomes the analysis of description, which is more closely to simulations and optimization [25]. Consumer behavior prediction becomes clearer by the modeling. This technique is more related to the processing of finding the relations between internal factors and external factors in segments of retailing, communicating, finance, and marketing [6]. Sometimes, this technology can be used in some festivals to analyze customers' consumer habits in a certain time. Additionally, it is possible for enterprises to learn the reasons why consumers give up a brand and turn to another brand in the same field, which proves that the consumption habits are clearly learned by big data system. Dividing consumers by keywords they have entered in the search engine, and recording real-time online behavior trajectories such as shopping history, comments on social media, and preferred readings, are both measures taken to achieve precise marketing by subdividing consumer groups. Emotions and psychological factors are quite significant for consumer behavior. Big data analysis can react quickly to what people "like" on social media (e.g., Facebook and Twitter), to receive real-time responses to make adjustments. Meanwhile, some models (e.g., the SIPS model including "sympathize", "participate", and "share and spread") are developed, marking that necessary adaption for the digital age. Big data analysis has been extended to be used in distinctive business models and patterns. Data platform pattern is an example to demonstrate the possibilities and the superiority of big data analysis. Data sharing, analysis, and trading can be achieved by the construction of the data platform. Innovative firms can benefit from the functions of storage, calculating, and analyzing. The asset of data then can be used in data integration and database, making suggestions for behavior predictions, creating development environment for applications to gain profits for developers.

5. Comparison

Compared to the traditional prediction ways of collecting data, big data analysis is proven to be more rapid, efficient, and high-volume. It is showing the capability to collect a large number of figures

in a relatively short time. It can verify, analyze, and manage zettabytes of information of different types [17]. For instance, an individual's pregnancy and the due date can be estimated by a company known as Target a few weeks before its competitors, which almost relies on big data analysis. Besides, this company tries to capture its sales by taking advantage of its own database which predicts its target consumer behavior. These measures have an effect on developing long-term relationships with customers and outperforming the competition in the same industry. Big data analysis has superior calculation speed, much larger sample sizes, and a more accurate database, stimulating the allocation of production means [12]. This strengthens its comparative advantage, making it possible to identify and analyze the database one step ahead of other competitors in the limited time.

Additionally, approaches based on big data analysis can convey and process data in various forms. Different sources contain applications, devices, text data, picture data, video data, sensors, and other networks. However, traditional consumer behavior prediction methods cannot manage these kinds of data. Big data analysis can effectively deal with structured data which is the database expressed by two-dimensional tables in a logical way, semi-structured data, and unstructured data which has no predefined data model, whereas conventional consumer behavior models cannot [17].

In addition, big data analysis is more suitable for the current transformation of the era of information and the Internet. It can be observed that consumers received product information from analyzing data and learning product properties from the Internet instead of receiving limited effective information from advertisements. The traces of these consumers are much clearer than in the previous days, i.e., making use of big data tracing people's preferences to improve marketing via social media can be an innovation to achieve accurate learning consumers' behavior and dig into their deep needs.

Moreover, corresponding analyzing models are becoming more and more effective and accurate. The appliance of big data analysis on consumer behavior can encourage innovations and enhance marketing strategies. Many more models are raised to cater to the development of big data era. To adjust to today's research, the AISAS model has been developed, which is based on the previous model known as AIDMA. New elements are "search" and "share" [12]. Based on the previous AIDMA model, the extended AISAS model is more appropriate to guide analysis on the Internet, which indicates the features of the Internet have an influence on consumers' attitudes, and at the same time, consumers cause corresponding purchase choices to fit the trend of the big data analysis [26]. Traditional modules are relatively limited in the integration of limited data from a macro level. The outcome of the analysis may give suggestions for the current phenomena instead of some advice for future further development. This is not appropriate for the setting of marketing strategies from the whole operation perspective and dimension. As mentioned above, emotional factors are difficult to catch by conventional prediction models, but big data technique have the access to consumers' real-time reactions to goods and service.

However, some weaknesses of big data analysis are worth discussing. Primarily, it is hard to complete data cleaning and guarantee that data extraction is effective. A large amount of data may be distracting, making it difficult to ensure the most valuable part of the whole database. In addition, sometimes the analysis model may be overfitting, making it difficult to analyze the population data out of the sample. Another point is that collecting, filtering, and analyzing data may need a lot of time, money, technology, and energy. The overall cost of analysis is relatively higher. Although big data analysis suggests a more efficient platform to integrate consumers' behavior and habits, more comprehensive marketing strategies should be made. More sensitive information and consumers characteristics should be collected to design distinctive marketing methods.

6. Limitations & Prospects

A comparison between big data analysis for consumer behavior and traditional prediction model has been made to enrich the relevant overview in the research field. However, data collection may exist limitations. It is relatively harder to identify the data authenticity and effectiveness. Secondly, some models may be too complex to accurately explain the data and analyze the overall population.

This may involve developing some new algorithms. Some other external sudden factors such as policy and wars may influence the research. Moreover, there is also a limitation to adjusting the model cycle. Some time periods are six months while some are one month. Therefore, it still requires considering whether additional research needs to be done to cover more data. Another point is that it is not enough for researchers to be limited in studying the machine learning model and other models based on big data analysis because facing practical use is much more important than being constrained in the study of theories. Analyzing specific situations and considering market background can deliver feasible marketing implementations. It is worth figuring out how to combine the analyzed outcomes with corporations' long-term objectives to make the most suitable marketing measures for the future. Maybe future research can be more focused on how to gather these two elements together to suit the era of big data. In the meantime, the ways to upgrade the existing conventional models and adjust to the rapidly growing digital age are still valuable for people to find out.

7. Conclusion

In summary, this paper discusses consumer behavior prediction based on big data analysis from the perspective of comparing it with conventional prediction models for consumer behavior study. Specifically, previous significant papers and research about consumer behavior are discussed. Besides, independent and dependent variables involved in consumer behavior studies are illustrated. According to the analysis, big data analysis is more suitable for the changing environment of the Internet age, and it is more efficient. More prediction models are developed and improved to cater to the emergence of the big data technology, encouraging more research topics on consumer behavior analysis sufficiently. In the future, some difficulties raised in big data analysis can be overcome by breaking the limit in data collection, model overfitting, the practical use of big data in the construction of marketing strategies and long-term development of enterprises, and adjustment of model cycle. Overall, these results offer a guideline of important models that have been applied in the big data and consumer behavior research, conveying the significance of the path to make consumer behavior analysis adapt to the Internet age.

References

- [1] Jisana, T. K. Consumer behaviour models: an overview. *Sai Om Journal of Commerce & Management*, 2014, 1(5): 34-43.
- [2] Wells V. K. Behavioural psychology, marketing and consumer behaviour: a literature review and future research agenda. *Journal of Marketing Management*, 2014, 30(11-12): 1119-1158.
- [3] Jeffries J. W. *Wartime America: The World War II Home Front*, 2018.
- [4] Moneesha, P. Consumer Behaviour: a Literature Review. *The Marketing Review*, 2001, 2(3): 319-355.
- [5] Kassarian, H. H. *The Development of Consumer Behavior Theory*, 1982.
- [6] Raorane A. and Kulkarni R. V. Data mining techniques: a source for consumer behavior analysis. *International Journal of Database Management Systems*, 2011, 3(3): 1-15.
- [7] Cruz-C'ardenas J., et al. COVID-19, consumer behavior, technology, and society: A literature review and bibliometric analysis. *Technological Forecasting & Social Change*, 2021, 173 (3): 1-13.
- [8] Foxall G. R. Invitation to Consumer Behavior Analysis. *Journal of Organizational Behavior Management*, 2010, 30(2): 92-109.
- [9] Purwanto G. A. Analysis of Consumer Behavior Affecting Consumer Willingness to Buy in 7-Eleven Convenience Store. *Universal Journal of Management*, 2013, 1(2):69-75.
- [10] Kotler P. and Armstrong G. *Principle of Marketing*, 2008.
- [11] Nisco A. D. and Oduro S. Partitioned Country-of-Origin Effect on Consumer Behavior: A Meta-Analysis. *Journal of International Consumer Marketing*, 2022.
- [12] Zhang C. and Tan T. *The Impact of Big Data Analysis on Consumer Behavior*, 2020.
- [13] Yilmaz K. G. and Belbag S. Prediction of Consumer Behavior Regarding Purchasing Remanufactured Products: A Logistics Regression Model. *International Journal of Business and Social Research*, 2016.

- [14] Lee S. Application of logistic regression model and its validation for landslide susceptibility mapping using GIS and remote sensing data. *International Journal of Remote Sensing*, 2005, 26(7): 1477-1491.
- [15] Koufaris M., Kambil A. and Labarbera P. A. Consumer Behavior in Web-Based Commerce: An Empirical Study. *International Journal of Electronic Commerce*, 2014, 6(2): 115-138.
- [16] Chaudhary K., Alam M., Al-Rakhami M. S. et al. Machine learning-based mathematical modelling for prediction of social media consumer behavior using big data analytics. *Journal of Big Data*, 2021, 8(73): 1-20.
- [17] Amado A., Cortez P., Rita P. et al. Research trends on Big Data in Marketing: A text mining and topic modeling based literature analysis. *European Research on Management and Business Economics*, 2018, 24(1): 1-7.
- [18] Ducange P., Pecori R. and Mezzina P. A glimpse on big data analytics in the framework of marketing strategies. *Soft Computing*, 2018, 22: 325-342.
- [19] Zuo Y., Yada K. and Ali A. B. M. S. Prediction of Consumer Purchasing in a Grocery Store Using Machine Learning Techniques. 2016 3rd Asia-Pacific World Congress on Computer Science and Engineering (APWC on CSE), 2016.
- [20] Muhtaroglu F. C. P., Demir S. and Obali M. et al. Business model canvas perspective on big data applications. 2013 IEEE International Conference on Big Data, 2013.
- [21] Erevelles Sunil., Fukawa Nobuyuki. and Swayne L. Big Data consumer analytics and the transformation of marketing. *Journal of Business Research*, 2016, 69(2): 897-904.
- [22] Anshari Muhammad., Almunawar M. N., Lim S. A. et al. Customer relationship management and big data enabled: Personalization & customization of services, 2019, 15(2): 94-101.
- [23] Giglio S., Pantan E., Bilotta E. and Melewar T. C. Branding luxury hotels: Evidence from the analysis of consumers' "big" visual data on TripAdvisor, 2020.
- [24] Jung S. H. and Jeong Y. J. Twitter data analytical methodology development for prediction of start-up firms' social media marketing level. *Technol Soc*, 2020.
- [25] Adebola O. and Onyekwelu B. Predicting Consumer Behaviour in Digital Market: A Machine Learning Approach.
- [26] Rangaswamy E., Nawaz N. and Changzhuang Z. The impact of digital technology on changing consumer behaviours with special reference to the home furnishing sector in Singapore. *Humanit Soc Sci Commun*, 2022, 9(83).