SPER Publications and Solutions Pvt. Ltd.

Original Article

# Modeling the Factors Affecting the Relative share of Sporting Brands in Mashhad Market

**Amir Dadrasmoghadam[1], Seyed Khosrou Etezad[2], Mohammad Ali Sahebkaran[3]*, Ali Barbaar[4], Mohammad Ghorbani[5]**

[1] Department of Agricultural Economics, University of Sistan and Baluchestan, Zahedan, Iran. [2] Academic Center for Education, Culture, and Research (ACECR) – Mashhad Branch & Ph.D. Student of Agricultural Economics, Ferdowsi University of Mashhad, Iran. [3] Assistant Professor of Sport Management, Faculty of Sport Sciences, University of Birjand, Birjand, Iran. [4] A faculty member of Islamic Azad University of Gonabad. [5] Professor of Agricultural Economics, Ferdowsi University of Mashhad, Mashhad, Iran.

**Correspondence:** Mohammad Ali Sahebkaran, Assistant Professor of Sport Management, Faculty of Sport Sciences, University of Birjand, Birjand, Iran. Email: Msahebkaran@yahoo.com.

## ABSTRACT

The purpose of the present study is to model the factors affecting the relative demand (share) of sports brands in the Mashhad market using the GFA method. The research sample consisted of 140 sports stores in Mashhad using a simple random sampling method. The information needed for this research was collected from 140 sports stores through a questionnaire in 2019. The studied variables included 69 independent variables affecting the share of sports brands. It was determined by the method of genetic algorithm function approximation which factors affect the share of Nike, Adidas, and other brands. The results of modeling showed that with the increase in the number of customers, the share of Nike sports brands increased. Nike's advertisement has hurt Nike's sports brand share in the Mashhad market. The preferred value of Puma's brand has increased the share of the Nike brand in the Mashhad market. The Adidas brand share has affected the average of Adidas' purchase price. The more the price of Nike increases, the more the share of Adidas brand decreases. The preferred value of the Asics brand has a positive relationship with Adidas in terms of diversity. Based on the results of this study, it can be suggested that the Nike brand should pay special attention to the diversity issue to increase its share in the Mashhad market. Also, to increase their shares in the Mashhad market, the brands in addition to price and diversity should consider the number of sales, education, preferred value, and advertising.

**Keywords:** Relative Demand, share of brand, Nike, Adidas, GFA, diversity, price

JEL Classification: M31, M14, L25

## Introduction

With increasing global competition, companies are looking for ways to increase their market share by differentiating products and services, as well as increasing the power of influence on consumer purchase intentions. One of the areas where companies and organizations can differentiate their products and services from other competitors is the brand area. In other words, brands can make organizations differentiated and profitable in the long run by attracting new customers and creating loyalty in their current customers. Today, the brand is one of the most valuable assets of the company in the field of competition. The more the value of the brand is in the minds of customers, the more benefits the companies can achieve from customers. In the new age, which is the era of integration and globalization of corporations, brand value is a key determinant of corporations' value and stock market value. A brand is one of the intangible assets of any company that is considered to be valuable. Therefore, in each market, the main goal of naming a product is that an organization can differentiate itself from the others in the commodity market. This event should ultimately affect consumers' behavior by name, such as increasing the number of participants in sports or increasing the number of fans for a particular event [1, 2].

| Access this article online | |
|---|---|
| **Website:** www.japer.in | **E-ISSN:** 2249-3379 |

**How to cite this article:** Amir Dadrasmoghadam, Seyed Khosrou Etezad, Mohammad Ali Sahebkaran, Ali Barbaar, Mohammad Ghorbani. Modeling the Factors Affecting the Relative share of Sporting Brands in Mashhad Market. J Adv Pharm Edu Res 2020;10(S4):63-69.
Source of Support: Nil, Conflict of Interest: None declared.

A brand is a name, phrase, term, sign, logo, symbol, design or combination of them which its purpose is to introduce a product or service by sellers to distinguish their products from competing companies. In the current competitive environment, most scholars believe that brands are an important part of the business. One of the requirements to create a strong brand is to recognize each of the factors that cause brand equity [3, 4].

Today, sporting consumers buy from stores where all goods (clothing, sports equipment, etc.) are presented. Facing a bunch of products that are identical in terms of shape and quality orientates the consumers' decision to purchase the branded products regardless of their characteristics. Brands have become so important in consumers' purchasing decisions that they are considered as the main assets of the corporation or organization [5]. The American Marketing Association (2006) has defined a brand as a name, word, sign, logo, or trademark for identifying and distinguishing a product or service of a worker or a group of manufacturers from their rivals.

Today, sports clothing is an important issue for many people in the community, and because of that young people are more optimal and comfortable with it and consumers are looking for famous brands. A strong brand causes an integrated image of the corporate to be associated in mind, and due to the use of this brand, growth and lower costs will be brought for corporate. The importance and impact of the brand are so that, although at first, it associates the optimality of goods and services in the mind of consumers, in the med-term with a continued presence in the market, it is a brand that confirms the quality and acceptability of goods and services. Therefore, a good brand can draw on certain interests of businesses and protects the supplied products from potential negative competitions and fraud. These symbols help companies to consistently reflect on their commitment to the good delivery of products and consolidate themselves in global markets and to compete with market headlines.

This has led manufacturers such as Nike and Adidas to begin to expand their brands, especially in Asia. These brands have the potential to achieve higher sales of products on the market. It has been estimated that over three fourth of the total active sportswear market and nearly 85% of the authentic shoes are branded. Sashi and Karuppur (2002) stated that successful brands could expand beyond national boundaries [8]. According to the Just Style website, the global sporting brands of Nike, Adidas and Reebok accounted for 33% of the sportswear market and sports shoes in 2007.

The industry of sporting goods is specified with the production of a large and spread volume of goods in different geographical regions. In the market of sporting clothes, the brands constantly try to stabilize and recognize brands and the development of new lines of sporting products to obtain a greater share of the market. The importance and necessity of the present study are that the variability of the brands of Nike and Adidas products in Mashhad sporting stores are 9.8 and 8.9, respectively. Also, the share of Nike and Adidas products in Mashhad sporting stores are 0.32 and 0.29, respectively. For this reason, the brands of Nike and Adidas that have the highest share and variability in Mashhad markets were selected as research variables (taken from the finding of the present research).

The objective of the present is to go beyond certain structures about the brand and common frameworks to research in this field. In this study, it was tried to fill the gap resulted from the lack of research on the share of brand because most researches selected several variables voluntarily and analyzed their effects on the share of brand; but in the present research, the and optimal factors affecting the share of brands in Mashhad market have been obtained through genetic function approximation algorithm. This research has studied the factors affecting the share of brands of Nike and Adidas in the Mashhad market that in this regard includes some innovations compared to other studies. Therefore, in the following sections, first, the review of the literature and theoretical principles are stated and then the analysis of the genetic function approximation algorithm and its results are presented, and in the end, the most important findings and suggestions are given.

## Method

The genetic algorithm is an inspiration of Darwinian evolution theory and is based on natural selection or the survival of the superiors. A common application of the genetic algorithm is to use it as an optimal function. A Genetic algorithm is a useful tool in pattern recognition, feature selection, picture understanding and machine learning [9-12]. The genetic algorithm was first proposed for engineering applications and other sciences including today's economy by John Holland (1975), the computer scientist at Michigan University [13]. His work is the beginning of all efforts to apply the genetic algorithm in engineering. Subsequently, Jong's work (1975) on the evaluation and comparison of several methods of genetic provided the theoretical principles for the subject matter. This algorithm is based on the evolutionary principle of "the stability of the superiors" that is inspired by nature.

The GFA algorithm deals with the fundamental problem of the function, in which many factors affect the response variable and the initial inputs are made for correlations with the best answer approximation [14]. The basis of the genetic algorithm is simple so that it searches for one or more code series. Each series is a position in the search space. The algorithm works with a range of series known as population and this population gets evolution and searches for this purpose. According to the GFA model, a search criterion is defined for each series. The three operators are implemented following it: 1-selection, 2- crossover, 3-mutation.

New members are rated according to the criterion fitness. In GFA, the scoring criterion for models is based on the quality of the regression fitted to the data. The selection possibilities should be added to each new member and reassessed for the population. This method is continued for a certain number of generations until convergence occurs [15, 16].

To fit the GFA model, the different statistical criteria can be obtained during the process. The LOF criterion is privileged to the minimum normal error criterion. According to Friedman

(1990), LOF is a criterion in which SSE is the total squares of errors, C is the number of base functions other than constant-coefficient, 'd' is the defined level parameter, 'p' is the properties obtained from all main functions, and M is the number of samples of the training stage. Unlike the criterion of the minimum normal squares, the LOF criterion cannot be increased by adding more variables to a regression model, while the new variable may reduce SSE and increase the value of C and 'p' and lead to an increase in the LOF scoring. So the SSE may be reduced by adding a variable, but the LOF score will increase [15, 16].

The GFA algorithm can be used to create a generation based on the time-evolution graph. Such a graph shows the number of events of each variable within the population for each evolved generation and is summed up for practical reasons to reduce data. Such a graph is generated only for variables that much occur in the final population. The abnormal data are aggregated for each generation. The GFA algorithm converges when there is no progress in population scoring and at that time that the model is significant. That model is the best situation for all population models [17].

The GFA algorithm has important advantages compared to other methods [18, 19] that are as followings:

1. This method can provide multiple models than a simple model.
2. This method can automatically select the features used in the model.
3. This method can better deal with discovering the composition of the variables (characteristics) based on the advantages of the correlation between multiple features.
4. The GFA algorithm provides the Friedman LOF error criterion and thus it can estimate the best number in terms of characteristics, stability, and fitness of the model which results in model stability.
5. This method can provide a domain of equations in terms of the type of model structure such as high order polynomial functions.
6. The GFA algorithm is an evolved method of the models and provides additional information from standard regression analyses such as a preferred model and a series of useful information for the data.

The statistics resulted from the modeling using GFA included the following:

**Friedman LOF**: It can be calculated as each equation by the following formula:

$$LOF = \mathrm{SSE}/(1-\frac{(c+df)}{n})^2 \qquad (1)$$

Where SSE is the total squares of errors, c is the number of base functions (other than constant-coefficient), 'd' is the adjustment parameter, 'f' is the total characteristics in the main function, and n is the number of input data. The uniform parameter d is calculated according to the following formula:

$$d = \alpha(n - p_{max})/p_{max} \qquad (2)$$

Where, Pmax is the maximum length of the equation (the maximum number of parameters in the equation, and 'α' is the adjustment parameter so that $0<\alpha<0.1$). The lowest Friedman LOF value is the least possibility in which the approximation of the genetic algorithm model is more fitted with data.

**$R^2$** is a fraction of the total variance of the Y variable that is obtained by genetic function approximation. The closer to one, the better it will show model approximation. With increasing the variables, $R^2$ tends to increase and equals to SSR/SST, where SSR is the sum of regression error squares and SST is the sum of the total squares.

**$\overline{R^2}$** decreases proportion to the size of the estimation model and equals to:

$$\overline{R^2} = 1 - \frac{\frac{SSE}{(n-p)}}{\frac{SST}{(n-1)}} \qquad (3)$$

Where 'p' is the number of parameters in the regression equation, $\overline{R^2}$ is adjusted according to the degree of freedom, which increases for a model with additional parameters. By adding the parameter, SSE, and degree of freedom decrease [15].

**Cross-validated R-squared ($R^2$)** is calculated by the following formula:

$$R^2 = 1 - \frac{PRESS}{SST} \qquad (4)$$

Where PRESS is the sum of the predicted squares. This $R^2$ is a key criterion to predict the power of the model. The closer one is, the more percentage it has to predict. For a good model, the credible cross-validated $R^2$ must be close to $\overline{R^2}$ or less. If this $R^2$ is a little more than $\overline{R^2}$, the model is most likely to be re-assessed [15].

**F-test**: The significance of the parameter is measured by F-test. To measure the equality of variance of the two populations with normal distribution, F-test is used. It is calculated as follows:

$$F = \frac{\frac{SSR}{(P-1)}}{\frac{SSE}{(n-P)}} \qquad (5)$$

Where SST is the sum of the total squares, SSE is the sum of error squares, and SSR is the sum of regression squares. N.SSE-SST=SSR is the number of observations, and P is the number of parameters in a regression model.

**Replicate point** is the number of repeated observations.

**Computed experimental error:** It is the experimental errors of the replicated data obtained by the following formula:

$$CER = (\frac{SSPE}{\text{Replicated points}})^{1/2} \qquad (6)$$

Where, SSPE is the sum of squares of net error [15].

**Fitness of points for LOF-test**: the number of fitted points for the LOF-test.

**Main experimental error for non-significant LOF (95%):** It is the least value of experimental error for non-fitness of the model and is obtained by the following formula:

$$MEELOF = \left(\frac{\text{SSLOF}}{(n-p-df_{pe})/F_{cr}}\right)^{1/2} \qquad (7)$$

Where, SSLOF=SSE-SSPE, and equals to the sum of the squares of non-fitness [15].

The statistical population of this study, which was obtained by questionnaire, consisted of data on 140 sporting stores in Mashhad that to obtain them, simple random sampling was used. Variables include the price, the share of brands (Nike and Adidas and rivals), and the product variety of the brands. In general, variables for modeling by genetic algorithm function approximation include the following items (Table 1):

**Table 1: Variables used for modeling**

| Variables | Abbreviation |
|---|---|
| Store size (1, 2 &3) | a1 |
| Urban area (1-North, 2-Center, 3-South, 4-East, 5-West) | a2 |
| Number of customers | a3 |
| Income and economic levels (1-High income area, 2-middle area,3-low income or downtown) | a4 |
| Seller's age | a5 |
| Education (1-elementary, 2-Guidance school, 3-High school and diploma, 4-Associate degree, 5-Undergraduate or higher) | a6 |
| Experience level (years) | a7 |
| Another job (1-yes, 2-No) | a8 |
| Average (1-low income, 2-medium, 3-high income). | a9 |
| Nike's advertising | a10 |
| Adidas' advertising | a11 |
| Asics' advertising | a12 |
| Puma's advertising | a13 |
| Reebok's advertising | a14 |
| Ombro's advertising | a15 |
| First-rate of Kappa's advertising | a16 |
| First-rate of Uhlsport's advertising | a17 |
| Lotto's advertising | a18 |
| Average purchase price of Nike | a19 |
| Average sale price of Nike | a20 |
| Weekly sales of Nike | a21 |
| Average purchase price of Adidas | a22 |
| Average sale price of Adidas | a23 |
| Weekly sale of Adidas | a24 |
| The average purchase price of the rest of the brands | a25 |
| The average selling price of other brands | a26 |
| The number of weekly sale of other brands | a27 |
| Color diversity of Nike | a28 |
| Quality diversity of Nike | a29 |
| Color diversity of Adidas | a30 |
| Quality diversity of Adidas | a31 |
| Color diversity of other brands | a32 |
| Quality diversity of other brands | a33 |
| Preferred value (price) of Nike brand | a34 |
| Preferred value (price) of Adidas brand | a35 |
| Preferred value (price) of Asics brand | a36 |
| Preferred value (price) of Puma brand | a37 |
| Preferred value (price) of Reebok brand | a38 |
| Preferred value (price) of Ombro brand | a39 |
| Preferred value (price) of Kappa brand | a40 |
| Preferred value (price) of Uhlsport brand | a41 |
| Preferred value (price) of Lotto brand | a42 |
| Preferred value of brands (diversity) of Nike | a43 |
| Preferred value of brands (diversity) of Adidas | a44 |
| Preferred value of brands (diversity) of Asics | a45 |
| Preferred value of brands (diversity) of Puma | a46 |
| Preferred value of brands (diversity) of Reebok | a47 |
| Preferred value of brands (diversity) of Ombro | a48 |
| Preferred value of brands (diversity) of Kappa | a49 |
| Preferred value of brands (diversity) of Uhlsport | a50 |
| Preferred value of brands (diversity) of Lotto | a51 |
| Preferred value of brands (availability) of Nike | a52 |
| Preferred value of brands (availability) of Adidas | a53 |
| Preferred value of brands (availability) of Asics | a54 |
| Preferred value of brands (availability) of Puma | a55 |
| Preferred value of brands (availability) of Reebok | a56 |
| Preferred value of brands (availability) of Ombro | a57 |
| Preferred value of brands (availability) of Kappa | a58 |
| Preferred value of brands(availability) of Uhlsport | a59 |
| Preferred value of brands (availability) of Lotto | a60 |
| Preferred value of brands of Nike (before entering the store) | a61 |
| Preferred value of brands of Adidas (before entering the store) | a62 |
| Preferred value of brands of Asics (before entering the store) | a63 |
| Preferred value of brands of Puma (before entering the store) | a64 |
| Preferred value of brands of Reebok (before entering the store) | a65 |
| Preferred value of brands of Ombro (before entering the store) | a66 |
| Preferred value of brands of Kappa (before entering the store) | a67 |
| Preferred value of brands of Uhlsport (before entering the store) | a68 |
| Preferred value of brands of Lotto (before entering the store) | a69 |
| Share of Nike brand | a70 |
| Share of Adidas brand | a71 |
| Share of the other brand | a72 |

(Source: findings of the research)

The modeling of factors affecting the share of sporting brands was performed using the genetic algorithm function approximation and MS modeling software to determine which of the 69 independent variables affect the share of sporting brands. Specifications for the genetic algorithm function approximation are presented in Table 2:

**Table 2: Characteristics of the genetic algorithm function approximation**

| Variable | Value (N) |
|---|---|
| Population | 50 |
| Number of generations | 50 |
| Possibility of mutation | 0.01 |

(Source: Research findings)

## Results and Discussion

According to the results obtained from Table 3, one of the factors affecting the share of Nike brand is the number of customers that is positive and shows that increasing the customers' number increases the share of Nike's sporting brand. Nike's advertising harms the share of Nike's sports brand in the Mashhad market. Nike diversity factor has been positive which means that increasing the color diversity of Nike will enhance Nike's share in the Mashhad market. The diversity of the other brands in terms of color has been negative which shows that increasing the diversity of other brands in the market has reduced Nike's share. The preferred value (price) of the Puma brand is 0.031 which means that the preferred value of the Puma brand has increased the share of the Nike brand in the Mashhad market. The preferred values of Ombro and Kappa brands (availability) also have reduced the share of Nike in the sports shoe market. Also, the goodness fitted coefficient is 0.99 which means that the independent variables can justify 99% of changes in the dependent variables. The F-test is also 4.24 indicating the significance of the whole model. Friedman's LOF criterion is similar to the criteria error in the model of normal least squares which was obtained equal to 0.0018. An experimental error model for calculations that yields an experimental error of duplicate data is zero. The minimum value of the LOF experimental error in 95% interval was obtained equal to zero at a 95% level for disproportion of the model and this is the best optimal model that has been estimated by the genetic algorithm function approximation for the share of Nike brand.

**Table 3: The statistical results obtained from the regression of the Nike share**

| **S1=0.003a3-0.028a10+0.006a31-0.004432+0.031a37-0.03a57-0.027a58+0.6** | |
|---|---|
| **Critical SOR F-value (95%)=4.24** | Friedman LOF= 0.0018 |
| **Repeated data=0** | $R^2$=0.99. |
| **Experimental error of calculation=0** | $\overline{R^2}$=0.98 |
| **Cross validated $R^2$=0.94** | |
| **The least non- significant error of LOF(0.95)=0** | F= 166.31 |

(Source: Research findings)

According to Table 4, one of the factors affecting the share of Adidas brand is the average purchase price of Adidas. The preferred value of the Nike brand has negative in terms of price which means that the higher Nike's price, the lower the share of Adidas' brand. The preferred value of the Asics brand in terms of diversity is positively related to Adidas' share. The preferred values of Nike and Reebok brands have been positive in terms of availability which indicates that with easy access to these brands, the share of Adidas brand in the sporting shoe market of Mashhad decreases. Reebok's diversity in terms of preferred value has increased the share of Adidas brand in the Mashhad market. A goodness fit coefficient obtained equal to 0.99 which means that independent variables can explain 99% of the variation of the dependent variable. F-test (estimator) is 166.31, which confirms the significance of the whole model. Friedman's LOF criterion was also calculated as 0.0018 which suggests an error in the model. The experimental error of calculations is zero and this is the best optimal model of regression estimated by the genetic algorithm function approximation for the share of the Adidas brand.

**Table 4: The statistical results obtained from the regression of Adidas share**

| **S2=0.0000000023a22-0.49a34+0.065a52+0.011a54-0.11a47+0.02a52+0.056*a56** | |
|---|---|
| **Critical SOR F-value (95%)=** | Friedman LOF=0.00007 |
| **Repeated data=0** | $R^2$=0.99 |
| **Experimental error of calculation=0** | $\overline{R^2}$=0.98 |
| **Cross validated $R^2$=0.97** | |
| **The least non- significant error of LOF(0.95)= 0.0057** | F=153.85 |

(Source: Research findings)

According to Table 5, education is one of the factors affecting the share of other sporting brands in the Mashhad market which has positive by a coefficient of 0.039. Asics advertising has been positive by a coefficient of 0.44 and suggests that Asics' advertising increases the share of sporting brands available in the Mashhad market. The weekly sales of Adidas are positively correlated with the share of other brands in the market. The coefficients of the preferred values of Adidas and Reebok brands (in terms of diversity) are 0.161 and 0.64, respectively indicating that by increasing the diversity of these brands that are required by customers, the share of sporting brands in Mashhad market increases, but it has a negative correlation with the preferred value of Asics brand (in terms of price). $R^2$ of the model shows that the independent variables can interpret 99% of the variation in the dependent variable. The F estimator is 153.85, which confirms the significance of the whole model. Freidman's LOF criterion is calculated as 40200 and indicates the error in the model. The experimental error of calculations is zero and this is the optimal model of regression that is estimated by the genetic algorithm function approximation for the share of other sporting brands in the Mashhad market.

**Table 5: The statistical results of the regression for the share of other brands**

| **S3=0.039*a6+0.044*a12+0.0000001a24-0.091a36+0.161*a53+0.064*a47+0.132** | |
|---|---|
| **Critical SOR F-value (95%)=4.24** | Friedman LOF=0.0017 |
| **Repeated data=0** | $R^2$=0.99 |
| **Experimental error of calculation=0** | $\overline{R^2}$=0.98 |
| **Cross validated $R^2$=0.96** | |
| **The least non- significant error of LOF(0.95)= 0.011** | F=172.98 |

(Source: Research findings)

## Conclusion and Suggestions

The present study was carried out to investigate the factors affecting the share of sporting brands in the Mashhad market. One of the factors affecting the share of Nike brand is the number of customers that by increasing the number of the customers, the share of Nike's sporting brand is increased. Nike's advertising harms the share of Nike's sporting brand in the Mashhad market. With increasing Nike's diversity, the share of Nike is increased in the Mashhad market; and increasing the diversity of the other brands in the market has reduced the share of Nike. The preferred value of the Puma brand has increased the share of the Nike brand in the Mashhad market.

One of the factors affecting the share of Adidas brand is the average purchase price of the Adidas brand. The more Nike's price increases, the more the share of Adidas is reduced. The preferred value of the Asics brand in terms of diversity is positively related to Adidas' share. The preferred values of Nike and Reebok brands have been positive in terms of availability indicating that with easy access to these brands, the share of the Adidas brand in the sporting shoe market of Mashhad decreases. Education is one of the factors that positively affect the share of other brands in the market of Mashhad. Asics' advertising increases the share of the sporting brands available in the Mashhad market. The number of weekly sales of Adidas is positively correlated with the share of the other brands available in the market.

In general, based on the results of the study we can present the following suggestions to increase the share of sporting brands in Mashhad market:

To increase its share in the Mashhad market, Nike brand must pay special attention to the diversity of goods. One of the reasons that the brand has been capable to have a special share in the Mashhad brand market has been attention to diversity capable to be presented in the market.

To increase its share in the Mashhad market, Adidas brand must consider the average purchasing price of the Adidas brand. Based on the results of the present study, it can be suggested that Nike must pay special attention to consumers' reactions to the prices of Nike to increase its share.

Also, to increase their shares in the Mashhad market, the brands, to pay attention to the variables of the price and diversity among other variables, the number of sales, consumers' education, the preferred value, and advertising must be considered.

## References


1. Aaker, D. A. Managing Brand Equity: Capitalizing on the Value of a Brand Name, 1991.
2. Mazurek M. Brand Reputation and its Influence on Consumers' Behavior. InContemporary Issues in Behavioral Finance 2019 Jul 4 (pp. 45-52). Emerald Publishing Limited.
3. Keller KL, Aaker DA. The effects of sequential introduction of brand extensions. Journal of marketing research. 1992 Feb;29(1):35-50.
4. Kotler P, Gertner D. Country as brand, product, and beyond: A place marketing and brand management perspective. Journal of brand management. 2002 Apr 1;9(4):249-61.
5. Gladden JM, Funk DC. Understanding brand loyalty in professional sport: Examining the link between brand associations and brand loyalty. International Journal of Sports Marketing and Sponsorship. 2001 Mar 1;3(1):54-81.
6. Katler, P., K. L. Keller. Marketing Management, 12th Edition, Upper Saddle, 2006.
7. Maruyama Ú, Quintanilha MV, dos Santos Silva CM, Sanchez PM. Sustainability and green marketing challenge: Brazilian brewing industry case study. Brazilian Journal of Operations & Production Management. 2019 Mar 7;16(1):78-87.
8. Sashi CM, Prasad Karuppur D. Franchising in global markets: towards a conceptual framework. International Marketing Review. 2002 Oct 1;19(5):499-524.
9. Tseng LY, Yang SB. Genetic algorithms for clustering, feature selection and classification. InProceedings of International Conference on Neural Networks (ICNN'97) 1997 Jun 12 (Vol. 3, pp. 1612-1616). IEEE.
10. Bala J, Huang J, Vafaie H, DeJong K, Wechsler H. Hybrid learning using genetic algorithms and decision trees for pattern classification. InIJCAI (1) 1995 Aug 20 (pp. 719-724).
11. Vafaie H, De Jong K. Genetic algorithms as a tool for feature selection in machine learning. InProceedings Fourth International Conference on Tools with Artificial Intelligence TAI'92 1992 Nov 10 (pp. 200-203). IEEE.
12. Vafaie H, Imam IF. Feature selection methods: genetic algorithms vs. greedy-like search. InProceedings of the International Conference on Fuzzy and Intelligent Control Systems 1994 Mar (Vol. 51, p. 28).
13. Holland JH. Adaptation in natural and artificial systems: an introductory analysis with applications to biology, control, and artificial intelligence. MIT press; 1992.
14. Rogers D, Hopfinger AJ. Application of genetic function approximation to quantitative structure-activity

relationships and quantitative structure-property relationships. Journal of Chemical Information and Computer Sciences. 1994 Jul;34(4):854-66.

15. Samuel, H. Uzairu, A. Mamza1, P., Oluwole Joshua, O. Quantitative structure-toxicity relationship study of some polychlorinated aromatic compounds using molecular descriptors. Journal of Computational Methods in Molecular Design, 2015; 5 (3):106-119.
16. Ma Y, Ma K, Wang H, Geng X, Gao J, Zhu Z, Wang Y. QSPR modeling of azeotropic temperatures and compositions for binary azeotropes containing lower alcohols using a genetic function approximation. Chinese Journal of Chemical Engineering. 2019 Apr 1;27(4):835-44.
17. Prosenjit B, J. Thomas, L., Kunal, R. Exploring QSAR of thiazole and thiadiazole derivatives as potent and selective human adenosine A3 receptor antagonists using FA and GFA techniques Chemistry. Journal of molecular modeling, 2005; 11 (6): 516-24.
18. Khaled KF. Modeling corrosion inhibition of iron in acid medium by genetic function approximation method: A QSAR model. Corrosion science. 2011 Nov 1;53(11):3457-65.
19. Khajeh A, Modarress H. QSPR prediction of flash point of esters by means of GFA and ANFIS. Journal of hazardous materials. 2010 Jul 15;179(1-3):715-20.