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Designing the distribution channel selection system in the supply chain of the oil industry using the combination of adaptive neural-fuzzy network and meta-heuristic algorithms

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Abstract

The purpose of this research was to design a distribution channel selection system in the supply chain of the oil industry using the combination of adaptive neural-fuzzy network and meta-heuristic algorithms (Case study: National Oil Products Distribution Company of the dual regions of West Azerbaijan). This research was based on the purpose of the research, developmental-applicative and based on the descriptive-modeling research method. The statistical population of this research was 185 axis sales, Sekodar and fuel supply stations in the two regions of North and South of West Azarbaijan province. In this research, questionnaires and documents were used to collect data. In order to analyze the data, confirmatory factor analysis, adaptive neural-fuzzy network in basic mode and adaptive neural-fuzzy network combined with genetic meta-heuristic algorithms and particle swarm have been used. In this research, first, the combined distribution channel selection system was designed, and then using the system designed based on the least error, the traditional distribution channel and the branding plan of the fuel stations were evaluated based on the input scores. The results show that the best system for selecting the distribution channel was the adaptive neural-fuzzy network combined with the particle swarm algorithm. By comparing the performance of the branding plan and the traditional method, it was determined that the branding plan has a better performance and is a suitable distribution channel for the National Oil Products Distribution Company of the dual regions of West Azerbaijan.

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Extended Abstract

Introduction

Rapid changes in consumer purchasing behavior, along with supply chain redesign, have caused both existing and new retailers to implement a variety of new inventory management strategies (Zhang et al., 2017; Melis et al., 2015). According to Forbes magazine, companies like Wal-Mart are known as the biggest companies in terms of sales (Forbes, 2014). The success of these companies is strongly related to the strategy and proper operations of the supply chain (Bogenrief, 2012). Some companies around the world (such as Amazon, Apple, Coca-Cola, Dell and Nike) attribute at least part of their success to supply chain management. At the same time, the results of the survey conducted in 2012 show that less than half of company managers recognize supply chain management as a strategic asset. In general, companies that recognize supply chain management as a strategic asset and use it in their daily processes, on average, achieve 70% higher financial performance (Kozlenkova et al., 2015). Since one of the main concerns of marketing is providing value to the consumer and the final user, an efficient supply chain is perhaps the most essential marketing function. Any mistake anywhere in the supply chain can have two-way effects for the company and its customers (Ellis, 2011). On the other hand, an effective and efficient supply chain allows companies to deliver higher value to final customers and improve results for the company. Marketing distribution channels are where the process of creating customer value in the supply chain is more prominent (Kozlenkova et al., 2015). Distribution channels and their proper use can help to increase the competitiveness of companies (Gong et al., 2023); therefore, distribution channel management is considered as an important task (Berling et al., 2023; Chen et al., 2014; Chiang, et al., 2003).

Based on the above discussions, the approach of paying attention to the distribution channels in the supply chain is a problem that has led the researcher to conduct this research. This issue originated from two main areas. On one hand, the researcher's studies show that there is a lack of research in the field of choosing distribution channels in supply chain management, and the knowledge gap in this field is clearly visible. On the other hand, due to the fact that the National Oil Products Distribution Company of Iran, in a new approach, is looking for branding and creation of oil products distribution chain companies, which is the first of its kind in Iran; in such a situation, the need to design a supply chain distribution channel selection system in distribution companies can make it possible for managers of oil products distribution companies to choose appropriate distribution channels, develop appropriate cooperation, and understand priorities in relation to the members of the channel and identify the desired channel. In such a situation, methods such as artificial intelligence can be helpful. One of the methods of artificial intelligence is adaptive neural-fuzzy networks.

Research methodology

This research is applicable in terms of purpose, and descriptive-modeling in terms of the research method. Based on the nature of research variables, the statistical population of this research has been investigated in two parts. In the first part, the main statistical population of this research was axis sales, Sekodar and fuel supply stations in the two regions of North and South of West Azarbaijan Province.

To determine the validity of the questionnaire, two relative coefficients of content validity and content validity index were used. The results of these two coefficients indicate the elimination of some measures and confirm the validity of the questionnaire. The final parameters of the research based on inputs and outputs are shown in table (3).

Cronbach's alpha coefficient has been used to determine reliability. Reliability was determined based on the original sample, and the results showed that the value of Cronbach's

alpha coefficient for all the main components was greater than 0.7, and based on this, the reliability of the questionnaire was confirmed.

In order to analyze the data in this research, the ANFIS method and its combination with genetic meta-heuristic algorithm and particle swarm were used to design the supply chain distribution channel selection system in the National Oil Products Distribution Company.

Findings

Confirmatory factor analysis

In order to verify the main components through the measured reagents, confirmatory factor analysis was used in Lisrel software. For confirmatory factor analysis, two categories of fit indices of the confirmatory model and factor loadings indicating the relationship between the main component and the indicators have been used. For the fit of the confirmatory model, the root mean square error of estimation (RMSEA) index, root mean square residual (RMR) index, goodness of fit index (GFI), adjusted goodness of fit index (AGFI), comparative fit index (CFI) and the normalized fit index (NFI) was used. The root mean square index of the estimation error should be less than 0.09, the residual mean square root index should be less than 0.05, and the values of the goodness of fit, adjusted goodness of fit, comparative fit and normalized fit indices should be greater than 0.9; to be able to claim that the verification model correctly verifies the main component. In the second part, factor loadings and t values have been used to investigate the relationship between the main component and the variables. From an empirical point of view, the value of each factor load should be greater than 0.5, and from a statistical point of view, the corresponding t value of each factor load should be greater than 1.96. The results are shown in table (4).

The results of the suitability indices of the verification models in Table (4) show that the value of RMSEA is smaller than 0.09, the value of the RMR index is smaller than 0.05, the value of the goodness of fit indices, the adjusted goodness of fit, Adaptive fit and normalized fit are greater than 0.9. Also, the relative chi-square value was calculated smaller than 3, which indicated the appropriateness of all the verification models and the verification of the main input and output components in the model. Examining the relationship between the main component and the determinants through factor loadings also shows that all factor loadings are greater than 0.5. The statistical analysis of factor loadings through t values also shows that the t value obtained for all factor loadings is greater than 1.96 and is significant. Therefore, the results obtained for the reagents and the main components can be confirmed in general. As an example, the output of the software for operating loads and t values of the main component of channel tasks are shown in figures (3) and (4).

Discussion and conclusion

This article was formed based on this main question: how is the appropriate system for choosing distribution channels in the supply chain of the oil industry using the combination of adaptive neural-fuzzy network and meta-heuristic algorithms in the National Oil Products Distribution Company of the dual regions of West Azerbaijan? To answer, first the literature and theoretical foundations of the research were reviewed; and in line with that, the variables and indicators affecting the selection of distribution channels in the supply chain of the distribution companies of the National Oil Products Distribution Company were extracted. In the next step, confirmatory factor analysis was used to confirm the main components through the measured indicators in the studied statistical population. After confirming the main components and specifying the inputs and outputs of the supply chain distribution channel selection system in distribution companies, first the adaptive neuro-fuzzy system in the basic state was implemented, and the error of each system using the indices of mean square error

and root mean square error were calculated to determine the performance of each of them. After identifying the best adaptive neural-fuzzy system in the base state, in the second stage, the adaptive neural-fuzzy system is combined with meta-heuristic algorithms and finally the best distribution channel selection system in the supply chain of the National Oil Products Distribution Company in two regions of West Azarbaijan was determined based on the designed hybrid system.

Based on the results obtained, it is suggested to the executives to increase the quality of the distribution channel in the supply chain by factors such as creating mutual trust, attention should be paid to the infrastructure and facilities of the place when granting representation, the quality of the human resources of the placeholders and the level of capital submitted by the placeholders, and, evaluate each of these cases with a detailed investigation. In the branding method, in order to promote the brand, it is necessary to establish mutual trust between the main brand and the established brand, and the established brand defines its identity based on the original brand. The use of specialized and trained manpower in the branding method to increase the quality of distribution is one of the main requirements in the issue of distribution in the branding method, which needs to be addressed by providing multiple trainings to the existing employees. Also, the main brand can help the incumbents in accessing financial resources and new investments in the form of low interest loans.