Using Fuzzy Logic to Analyze Marketing Data: The Impact of Socio-psychological Variables on the National Identity of Jordanians

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Abstract:

Recently, fuzzy logic mathematics has started to change the perspectives in many management and marketing areas. Analyzing business data using the fuzzy logic approach can help marketers and managers to probe new insights in their data. The fuzzy approach provides not only intelligence but also allows such knowledge to be effectively captured in an enterprise-wide data warehouse. In addition, it helps managers to develop a group decision making model using fuzzy logic to establish customer preferences. This study applies fuzzy logic methodology to examine the influence of socio-psychological variables namely dogmatism, conservatism and world-mindedness on Jordanian consumers' national identity (NATID) levels. The concept of NATID is valuable for international marketers as consumers all over the world are exposed to a wider range of foreign products in their home countries. In the current study MATLAB® ANFIS has been used to model the relationship between three inputs dogmatism, conservatism, and world-mindedness and one output (NATID). To examine the ability of fuzzy logic model to predict Jordanians' NATID based on socio-psychological variables Data was collected from a total number of 183 Jordanians who live in Amman city during the winter and spring of 2010. Results indicate that fuzzy logic model can predict correctly consumers' NATID based on their dogmatism, conservatism and world-mindedness feelings. Finally, the study provides insights for local and international marketers to conduct their marketing activities more effectively. The study also proposes several suggestions for conducting further research.

Keywords

Fuzzy logic; Business intelligence; National Identity; Dogmatism; Conservatism; World-mindedness

Introduction:

Recently, most organizations have faced changes in their surroundings. These changes are branded by a highly competitive business environment, technological innovations, the saturation of domestic markets particularly in developed countries and the emergence of new communication tools (Keegan and Green, 2011). Unquestionably nowadays competition has pushed businesses to not only longer struggling for the superiority of product/service, but also for integrated system leadership (Papatya and Papatya, 2011). However, technology has changed business environment. In this context, Tonta (2005) indicated that even though technology helps to distribute information cheaply it inundates users with information that they might not need. Thus, information control is an important approach and helps consumers to select and process the relevant information they need (Ariely, 2000). Moreover, it is known that Internet technology has changed the shopping environment for some individuals and businesses all over the world (Pan, 2004), since technology has reduced the cost and the effort to get information about products (Tonta, 2005). Generally, the Internet has recently become one of the key sources of information about various products for some consumers (Chan, 2005). For example, websites currently provide consumers with information regarding their purchase enquiries. In addition, the number of consumers who purchase through the Internet has increased dramatically, but it should be borne in mind that regions such as Asia, Latin America and Eastern Europe are behind in development and growth of commerce as regards the electronic infrastructure, buyer acceptance and use of technology (Ulgado, 2002). Overall, the Internet helps marketers provides to create positive image about their businesses, to get and offer information about their products and services, to develop relationships with profitable customers, and to better understand their consumers' practices (Kursan and Mihic, 2010). In the same context, it is important to indicate that business intelligence helps companies to identify the sources and outcomes of certain occurrences which aid the companies to make better predictions, calculations and analyses. Wang and Wang (2008) defined business intelligence as different software solutions such as technologies and methodologies which are help managers and marketers to obtain the needed information to improve decision-making process. More specifically, business intelligence is related to a variety of analytical software which can supply companies and organizations with the needed information; however, there is a stress on the real-time information which supports reporting on every organizational level (Kursan and Mihic, 2010).

Background:

Data warehouse is emerging as one of the hottest areas of growth in global business and the critical component and tool for business intelligence which helps improve data analysis and decision support activities (Krishna and De, 2001). The highly competitive business environment and the increase risk of direct increase in strategic choices of the businesses have motivated many businesses to focus on business intelligence (Papatya and Papatya, 2011). It is known that data warehousing assists effective implementation of Multidimensional Decision Support System (MDSS). In this regards, it is vital to indicate that the fuzzy approach provides not only intelligence but also allows such knowledge to be effectively captured in an enterprise-wide data warehouse (Krishna and De, 2001).

Liu (2009) maintained that fuzzy logic approach helps managers to develop a group decision making model to increase their knowledge regarding their customer preferences. Overall, researchers should work on improving data analysis techniques in a way that provides more information regarding customer' preferences'. For example, for years business research data analysis has been conducting by a heavily relay on regression analysis. In this context it is important to indicate that fuzzy logic can be very useful in giving more precise information   regarding customers' preferences. Overall, fuzzy logic can advance data analysis in business research and can help researchers to probe new insights in their data (Enache, 2010). Al Ganideh et al, (2011) argued that fuzzy logic can improve consumer behavior research by providing international marketers with more accurate insights that regression analysis can do. Fuzzy mathematics has started to change the perspectives in many management and marketing areas (Enache, 2010). Generally, analyzing business data using the fuzzy logic approach can help marketers and managers to probe new insights in their data (Al Ganideh et al, 2011).

Fuzzy logic can help in developing the research of consumer behavior by giving accurate insights to local and global international marketers regarding every single customer preferences. On the other hand, traditional statistical techniques such as regression analysis can help researchers to get insights regarding the nature and the strength of the relationships between the variables.

Complexity and diversity of consumers' behaviours across countries that result from cultural dissimilarities have made it a key challenge to international companies (Pan, 2004). In 1996 Keillor et al, proposed a NATID measure to help global marketers to deal with international markets in a better way. The scale can help decision makers to conduct more effective marketing strategies by identifying critical areas of potential cultural conflicts and can offer marketers with good country analysis regarding country belief structure, cultural homogeneity, national heritage and ethnocentrism level. (Keillor et al, 1996). Overall, the NATID scale has been developed to empirically measure how strongly individuals in a given country identify with religious, historical, cultural and social aspects of their national identity (Keillor et al, 1996). Figure 1 shows the NATID framework which includes four main components namely, belief structure, cultural homogeneity, national heritage and ethnocentrism (Keillor et al, 1996).

Figure 1 National Identity Scale Dimensions (Keillor et al, 1996)
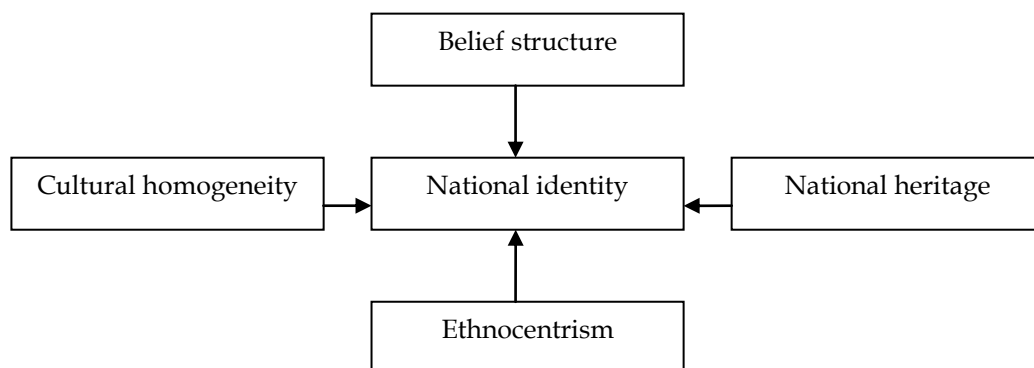
Source: Keillor and Hult, 1999, p. 68

The NATID scale consists of 17-items (Table 1). A good understanding of the NATID helps marketers to improve their global marketing activities such as promotional campaigns (Thelen and Honeycutt, 2004). Overall, the scale helps international marketers to develop more efficient and effective global strategies (Thelen and Honeycutt, 2004; Phau and Chan, 2003).

Table 1   The NATID Scale

No	Item
	National Heritage
1	Important people from the country's past are admired by people today.
2	One of the America's strengths is that it emphasises events of historical importance.
3	The United States has a strong historical heritage.
	Cultural Homogeneity
1	An American possesses certain cultural attributes that other people do not possess.

2   Americans in general feel that they come from a common historical background.

3   Americans are proud of their nationality.

4   People frequently engage in activities that identify them as American.

Belief System

1   A specific religious philosophy is what makes a person uniquely American.

2   It is impossible for an individual to be truly American without taking part in some forms of religious activity.

3   Religious education is essential to preserve the cohesiveness of American society.

4   A specific religious philosophy is not an important part of being American.

5   A true American would never reject his religious belief.

Consumer Ethnocentrism

1   We should purchase our products manufactured in the U.S.A instead of letting other countries get rich off us.

2   It is always best to purchase American products.

3   Americans should not buy foreign products because it hurts American business and causes unemployment.

4   It may cost me in the long run but I prefer to support American products.

5   Only those products that are unavailable in the U.S.A should be imported

Source: Keillor et al, 1996, p.62

Keillor et al, (1996) argued that their scale's four main components namely, belief structure, cultural homogeneity, national heritage and ethnocentrism do have real influence on consumers' purchasing behavior. For example, the history of a country is a central element of how that country perceives itself and other countries (Cateora et al, 2009). And thus, such an important issue should be taken into consideration while developing company's marketing activities and while taking branding decision. Moreover, it is important to specify that heritage contains cultural elements such as language, religion, customs and traditions along with national elements such as the country's flag, national monuments, and national natural resources (Maldonado et al, 2008). In addition, religions have many clear implications in people's daily life consumption Varul (2008). Thus, exploring the influence of religious beliefs on consumer behaviour is very useful for global marketers (Pepper et al, 2011). The consumer ethnocentrism concept could clarify why some consumers have negative attitudes towards foreign products. A review of the marketing literature highlighted the magnitude of results from and concerns of examining ethnocentrism among young consumers. Consumer ethnocentrism implies that purchasing foreign products is wrong, since it has serious consequences on the domestic economy and causes unemployment (Durvasula et al, 1997; Yu and Albaum, 2002; Orth and Firbasova, 2003; Guneren and Ozturn, 2008; Cleveland et al, 2009).

Overall, there is a dearth of studies which examine the influence of socio-psychological variables on consumers' NATID scores. This study extends previous research concerning the NATID by examining the influence of demographic and socio-psychological variables, namely dogmatism, conservatism, and world-mindedness, on NATID scores for Jordanian consumers employing fuzzy logic technique. Dogmatism can be defined as a character attribute that views reality in black and white (Caruana and Magri, 1996). Dogmatic individuals are those who hold beliefs and disbeliefs that are rigidly demarcated within the cognitive system (Crowson, 2009, p.265). Conservatism refers to 'a tendency to cherish traditions and social institutions that have survived the test of time and to introduce changes only occasionally, reluctantly and gradually' (Sharma et al, 1995, p.28). In the last decade, conservatism has become associated somehow in the U.S. to the political opinions that defend liberty, good character, strong families, and the importance of religion (Blitz, 2010, p.61). Generally, a commitment and devotion to the precedent is the core of conservatism (Strauss, 2011). World-mindedness refers to emotional support and empathy for the people of other countries' (Lee et al, 2003). It is a state of mind use humankind as reference group (Shankarmahesh, 2006). Balabanis et al, (2001) found that world-mindedness has no significant influence on consumer ethnocentrism for two samples from Turkey and the Czech Republic. However, Lee et al, (2003) concluded that world-mindedness has negative significant influence on consumer ethnocentrism in the U.S.A. Generally, it is important to examine the influence of socio- psychological antecedents such as dogmatism, conservatism and world-mindedness on NATID scores. That should help managers to better segment their consumers and to conduct their marketing activities more effectively. Dissimilarities between consumers in different countries still exist due to diversities in culture. The concept of NATID can help global marketers and mangers to differentiate markets and strategies and to position their products in domestic and global markets. Overall, it is dangerous for domestic and global marketers to suppose that

consumers all around the world are similar. Nevertheless, they need to know more about consumers and their attitudes all around the world.

Yet, this research is the first that offers those interested in the area of NATID all around the world more information and understanding about this phenomenon in Jordan. More specifically, this research aims to examine socio- psychological variables, namely dogmatism, conservatism and world mindedness as antecedents to consumer ethnocentrism for Jordanian consumers.

To examine the influence of socio- psychological variables namely, dogmatism, conservatism and world-mindedness on Jordanians' NATID, a survey was conducting during the spring of 2010. Data was collected from a total number of 183 Jordanians who live in Amman city during the winter and spring of 2010. The respondents were asked to answer a modified 17-item 5-point Likert format of NATID scale. Moreover, they were asked to answer 7-item 5-point Likert format Rawwas and Rejendran, (1996) world-mindedness scale and 5-item 5-point Likert format of Bruning et al,'s (1985) dogmatism scale. These two scales were used in marketing studies lately. To measure conservatism and due to the specialty of the Jordanian society the respondents were asked to answer 4 items 5-point Likert format related to tribes in Jordan, tribal law, honor killing, and the role of women in the political life in Jordan developed by Al Ganideh (2010). The Cronbach's alpha measure of internal consistency was carried out to assess the overall reliability of the used scales. All used scales have been found reliable as Cronbach's Alpha values have exceeded 0.60 for the four scales. Questionnaires were given to university students of two Jordanian governmental universities namely, the University of Jordan and Yarmouk University. The students who were selected randomly were asked to give the questionnaires to their family members who are interested in the topic of the research. It is important to indicate that business research in most of Arab countries have been influenced negatively by the lack of ready sampling frames. In addition, it is very hard to reach female subjects in many parts of Jordan and most Arab countries.

Analysis and Discussion:

Overall, fuzzy logic has been used to analyze data in the current study. Traditional statistical techniques such as regression is the common tool which most business researchers do utilize to analyze their data and to examine the strength and the direction of relationships between the variables of their studies.

Earlier in 1965, Zadeh has proposed adopting fuzzy logic in large number of science, engineering and business applications. Zadeh's suggested procedure had been developed based on the nation that in a traditional 0-1 interval an entity can be belongs either to 1 or to 0. Zadeh (1965) argued that objects within a particular interval should belong to it in different levels of belonging. The mechanism of a fuzzy logic system depends on in an input and output, however, there are four main components of a fuzzy system namely, fuzzification module, inference engine, knowledge base and defuzzification. Fuzzification module transforms a crisp input to its corresponding fuzzy value. In the current study MATLAB® ANFIS has been used to model the relationship between three inputs namely, dogmatism, conservatism, and world-mindedness and one output (NATID) (Figure 2). The following are the specifications of the used fuzzy inference system: type: name: 'FIS' ; type: 'sugeno'; andMethod: 'prod'; orMethod: 'probor'; defuzzMethod: 'wtaver' impMethod: 'prod'; aggMethod: 'sum'; input: [1x3 struct]; output: [1x1 struct]; rule: [1x1000 struct] trndata: [183x4 double].

Figure 2   Fuzzy System (Inputs-Dogmatism, Conservatism and World-mindedness Output-Jordanians' NATID)
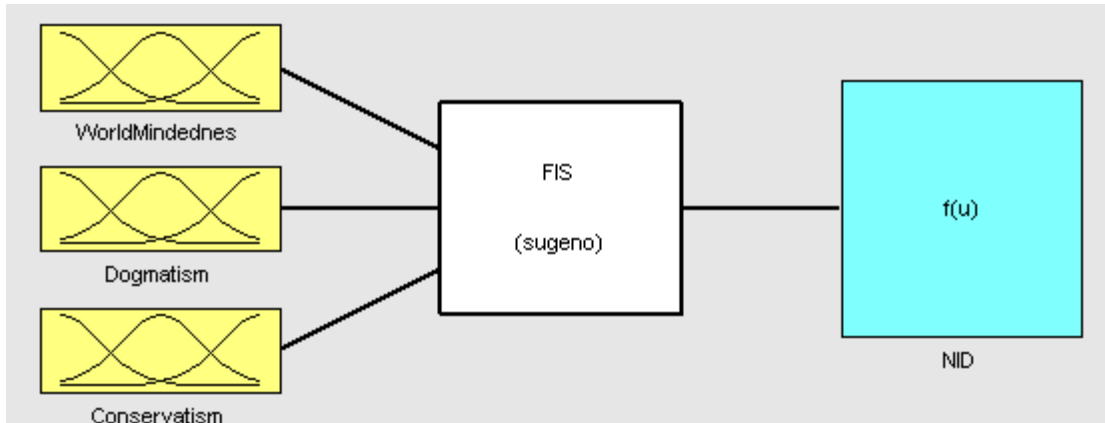
As the examined fuzzy system in the current study consists of three inputs and one output the form that expresses such system is (IF x is a1 and y is b1 and z is c1 Then f is h1x + i1y + j1z +r). Figure 3 shows the membership functions for the fuzzy model of the current study resulted from running the MATLAB® ANFIS (number of epochs is 1000).

Figure 3   Membership functions: Inputs-Dogmatism, Conservatism and World-mindedness Output-Jordanians' NATID
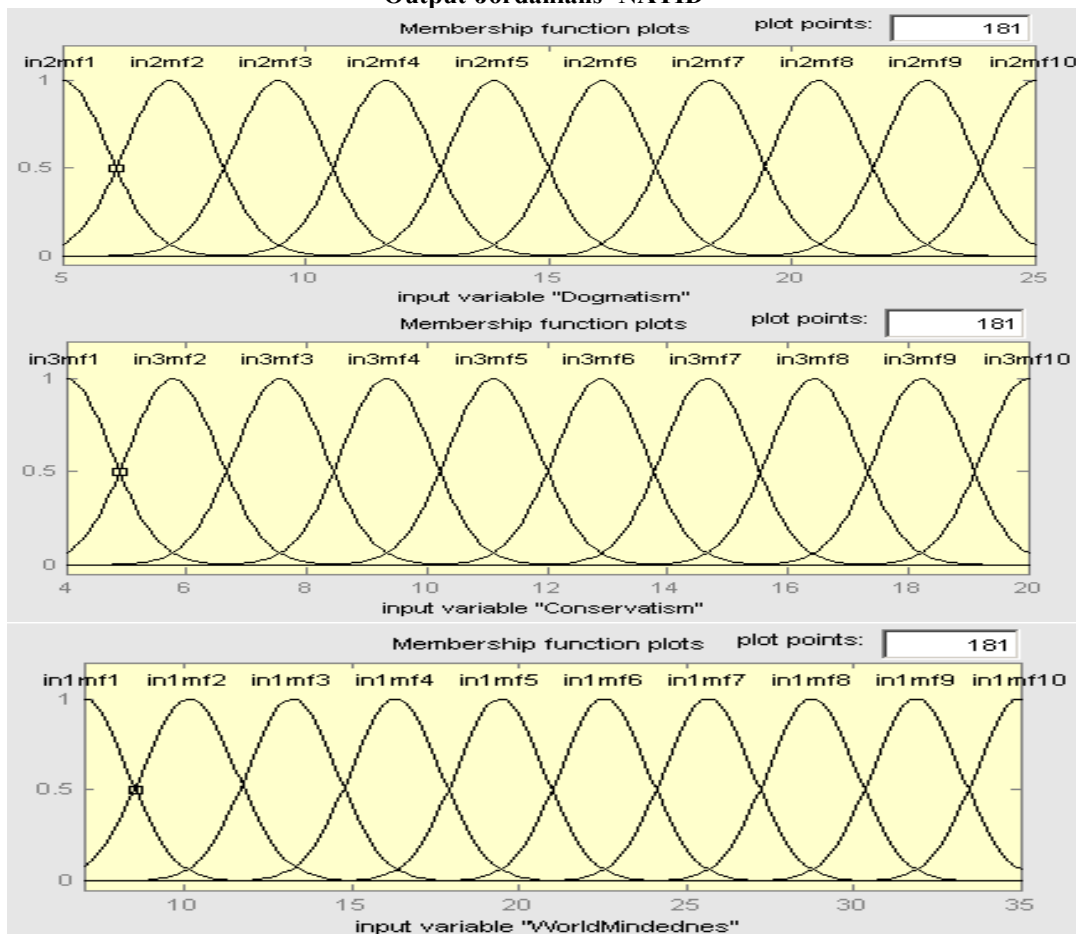

Figure 4 represents the relationship between each of the socio-psychological variables and the NATID score for Jordanian consumers. Overall, it can be noted that there are by some means positive relationships between dogmatism and conservatism and Jordanians' NATID score.

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Figure 4   The Relationships between Dogmatism (a) Conservatism (b) World-mindedness (c) and Jordanians' NATID
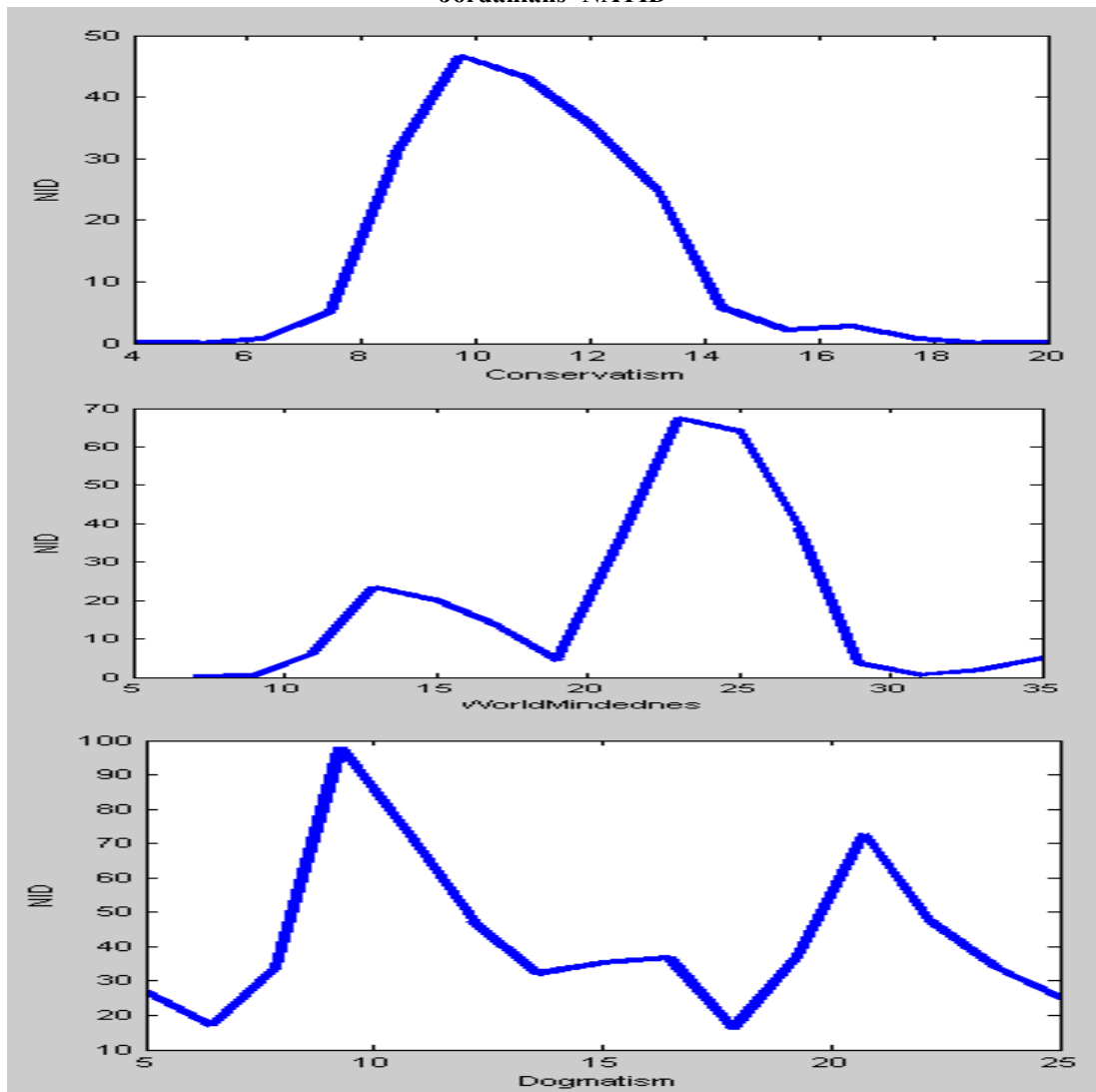
Fuzzy logic has central criteria of describing the influence of two inputs at one time on the overall output. Figure 5 represent three dimensional graphs that describe the effect of two inputs at a time on NATID. It can be concluded that the highest NATID score can be obtained for consumers who express high dogmatism level and high conservatism level. However, high world-mindedness score and high dogmatism score lead to low overall NATID score.

**Figure 5   Dimensional graph: (a) Dogmatism and World-mindedness and Jordanians' NATID
(b) World-mindedness and Conservatism and Jordanians' NATID (c) Dogmatism and
Conservatism and Jordanians' NATID**
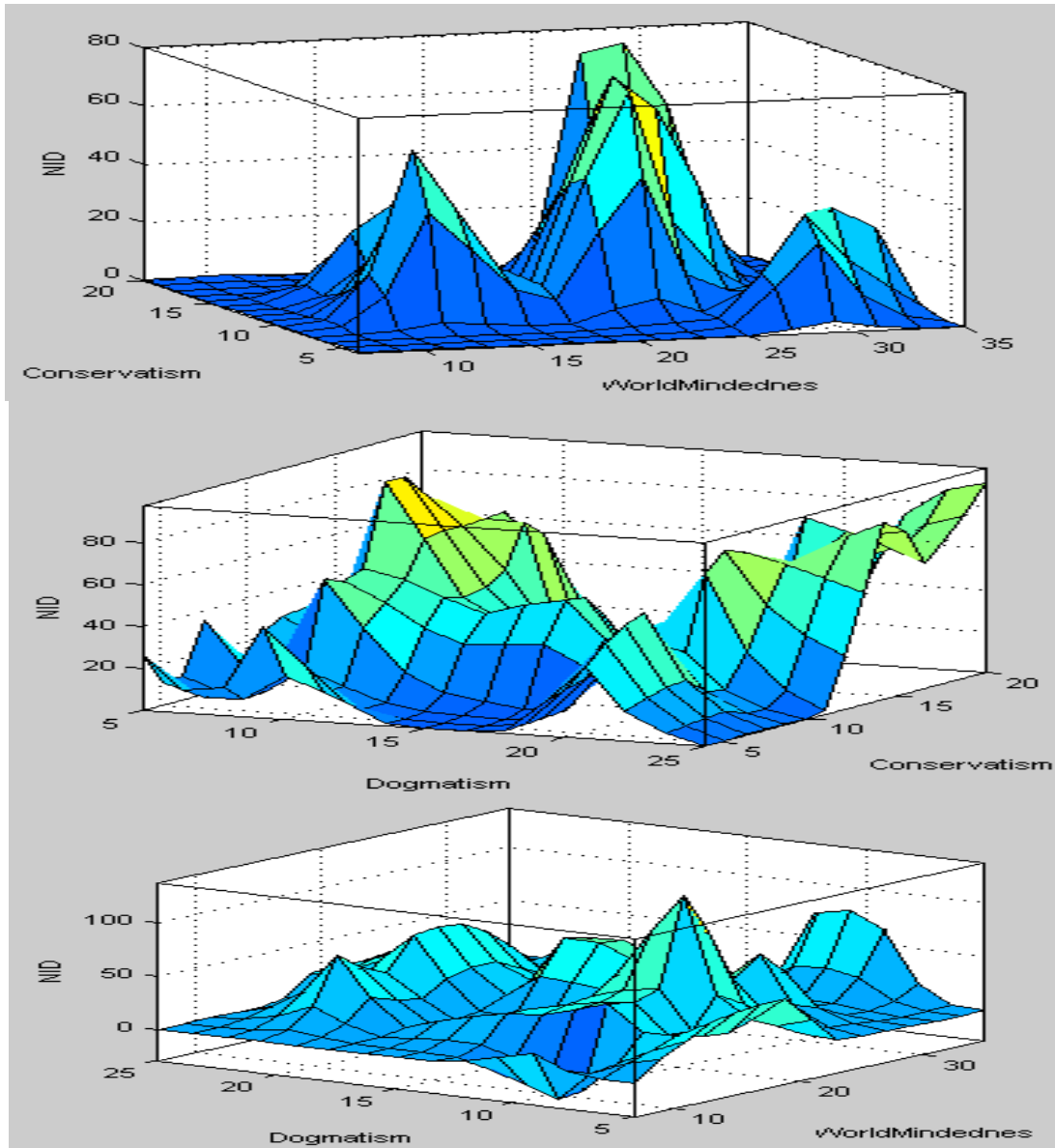
Generally, fuzzy logic can benefit managers and marketers by providing them with very precise values for individual consumers based on their dogmatism, conservatism and world-mindedness scores. For example, Figure 6 shows that a particular Jordanian respondent has scores of dogmatism (21), conservatism (20), and world-mindedness (7). The fuzzy logic model of the current study predicts that such a subject is supposed to score a value of NATID of 72.8. The real value that such a subject scored on the NATID score is 73.

Figure 6 An Illustrated Example 1: Inputs and output for a particular subject
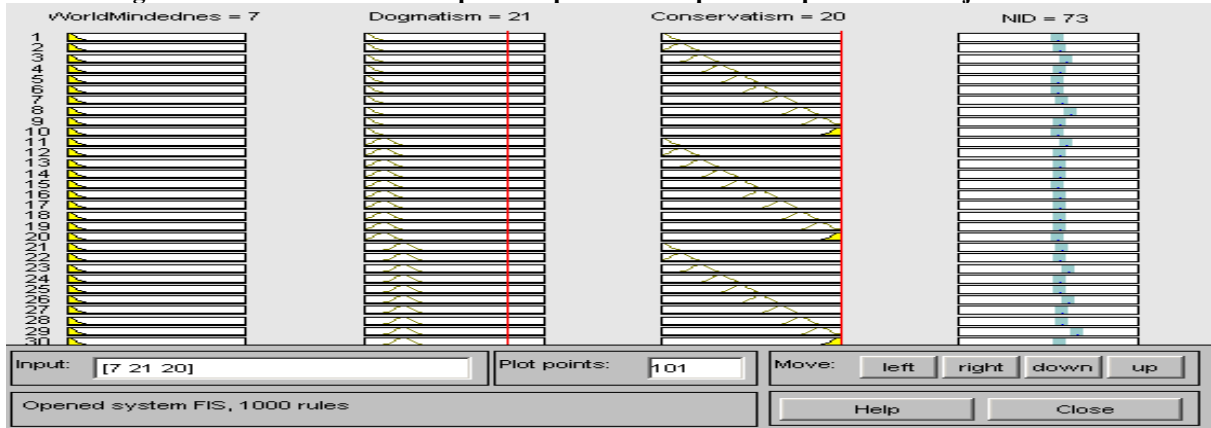

The second example (Figure 7) is regarding a customer who his values of dogmatism, conservatism, and world-mindedness are 14, 9 and 23 respectively. The customer real NATID score is 63. The fuzzy logic system predicts perfectly a NATID value of 63 for that customer.

Figure 7 An Illustrated Example 2: Inputs and output for a particular subject
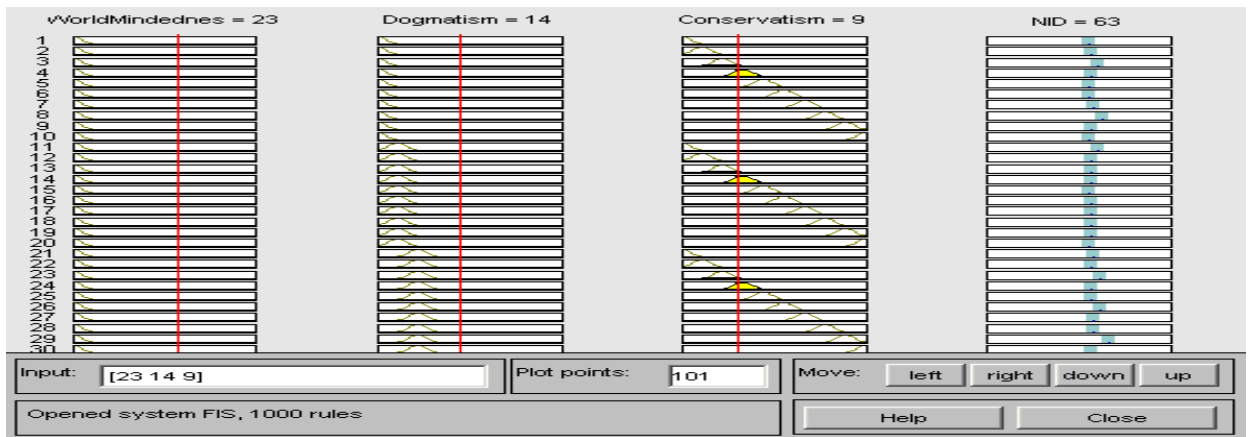
Finally, a female Jordanian consumer has expressed the following values of dogmatism (14), conservatism (9), and world-mindedness (23). The fuzzy logic system of the current study predicts again perfectly a value of 49.4 for this female consumer. However, the real value of NATID that this customer has scored is 49 (Figure 8).

Figure 8 An Illustrated Example 3: Inputs and output for a particular subject
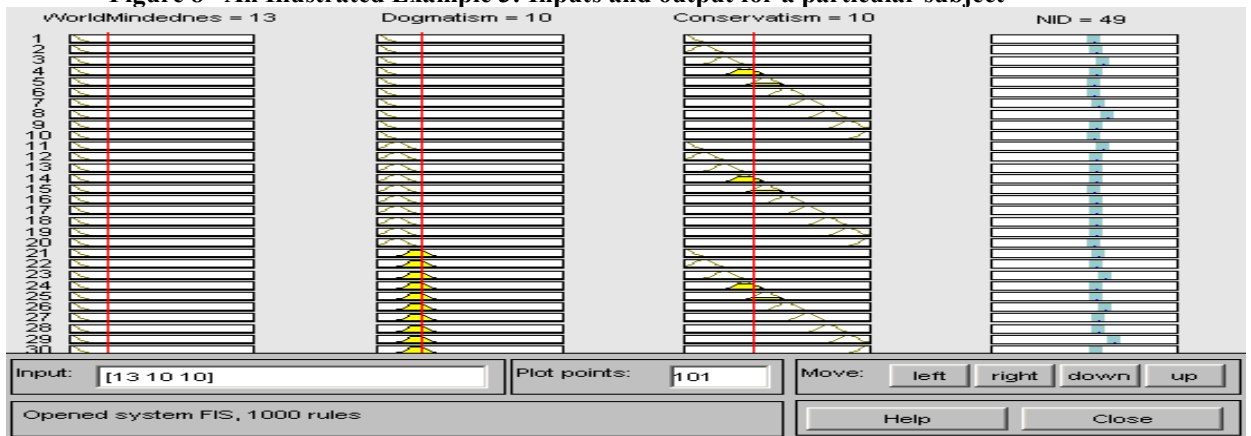
Overall, Applying fuzzy logic approach to predict Jordanian consumers' NATID scores level can contribute to improve global marketers' ability to predict perfectly the behavior of local and global customers. Fuzzy logic methodology has been employed to produce an overall output based on a model of three inputs. The used fuzzy logic model in this study has perfectly predicted Jordanian's NATID

scores based on their levels of dogmatism, conservatism and world-mindedness. The concept of NATID gives global and local marketing managers good insights regarding how to target local consumers' marketers with better understanding and more suitable marketing activities. Finally, this study contributes to knowledge on both academic and practical levels as it is the first study to apply the concept of fuzzy logic in consumer behaviour studies. International marketers and foreign investors who are targeting Jordanian consumers will be in a better position when they do understand the important set of cultural elements that influence Jordanian consumers.

This study can be considered as a step towards more understanding of fuzzy logic and its applications in business and marketing studies. The current study encourages academics and researchers to go on with applying fuzzy logic methodology in business and marketing research. For example, further research should examine ability of fuzzy logic mathematics to predict output based on input employing different marketing models. As this study has examined the influence of socio-physiological variables namely, dogmatism, conservatism and world-mindedness on Jordanians' NATID employing fuzzy logic technique future research should examine the influence of socio-physiological variables such as nationalism, patriotism, internationalism, and xenophobia on NATID using fuzzy Logic modeling. Technology and Internet has changed business environment dramatically. Examining to which level consumers in Jordan, a developing country do use Internet as a source of information is important. Overall, the results of this study research provide insights for local and international marketers to segment the Jordanian market more efficiently and efficiently.

References:

Al Ganideh S.F. (2010). Consumer Ethnocentrism in the Jordanian Market: The Impact of Socio-psychological Variables on Consumer Ethnocentric Tendencies". Journal of Business & Retail Management Research. **5** (1), pp.11-20.

Al Ganideh S.F., El Refae, G., and Aljanaideh, M. (2011) Can Fuzzy Logic Predict Consumer Ethnocentric Tendencies? An Empirical Analysis in Jordan. Journal of Physical Science and Application. 1(7) 2011, 100-106.

Ariely, D. (2000) Controlling the Information Flow: Effects on Consumers' Decision Making and Preferences. Journal of Consumer Research. 27 (September), pp. 233-248.

Balabanis, G., Diamantopoulos, A., Mueller and Melewar, T. (2001). The Impact of Nationalism, Patriotism and Internationalism on Consumer Ethnocentric Tendencies. Journal of International Business Studies. 32 (1), pp.157-175.

Blitz, M. (2010). What Conservatism Retains. Policy Review, 161, 61-71.

Bruning, E. R. (1997). Country of Origin, National Loyalty and Product Choice. The Case of International Air Travel. International Marketing Review. 14 (1) pp.59-74.

Caruana, A. and Magri (1996). The Effects of Dogmatism and Social Class Variables on Consumer Ethnocentrism in Malta. Marketing Inelegance and Planning. 14 (4), p.39.

Cateora, P. R., Gilly, M. C., Graham, J. L. (2009). International Marketing, Fourteenth Edition. NY: McGraw-Hill/ Irwin.

Chan, K. (2005). Store Visits and Information Sources among Urban Chinese Children. Journal of Consumer Marketing. 22 (4), pp.178-188.

Cleveland, M., Laroche, M., & Papadopoulos, N. (2009). Cosmopolitanism, consumer ethnocentrism and materialism: an eight-country study of antecedents and outcomes. Journal of International Marketing, 17(1), 116-146. http://dx.doi.org/10.1509/jimk.17.1.116.

CrowsonBruning, E.R., Kovacic, M.L., and Oberdick, L.E. (1985). Segmentation Analysis of Domestic Airline Passengers Markets. Journal of the Academy of Marketing Science, 13(1-2), 17-31.

Durvasula, S., Andrews, J., and Netemeyer, R. (1997). A Cross-cultural Comparison of Consumer Ethnocentrism in the United States and Russia. Journal of International Consumer Marketing. 9 (4), pp.73-93.

Enache, I.C. (2010). Marketing a Web-site Using a Fuzzy Logic Approach. Proceedings of the 10 International Conference on Risk Management, Assessment and Mitigation, 20-22 April 2010, Bucharest, Romania, 335-339.

Guneren E., & Ozturn A. (2008). Influence of ethnocentric tendency of consumers on their purchase intentions in north Cyprus. Journal of Euromarketing, 17(3-4), 219-231. http://dx.doi.org/10.1080/10496480802641096.

Keegan, W. and Green, M. (2011) Global Marketing. 6th Edition. Upper Saddle River, N.J: Prentice Hall.

Keillor, B., Hult, G., Erffmeyer, R. and Babakus, E. (1996). NATID: The Development and Application of a National Identity Measure for Use in International Marketing. Journal of International Marketing. 4 (2). pp.57-73.

Krishna, P.R, and De, S.K. (2001). A fuzzy approach to build an intelligent data warehouse. Journal of Intelligent & Fuzzy Systems 11 (2001) 23–32 23.

Kursan,I and Mihic, M. (2010). Business Intelligence: The role of the Internet in marketing research and business decision making. Management, Vol. 15, 2010, 1, pp. 69-86.

Lee, W., Hong, J. and Lee, S. (2003). Communicating with American Consumers in The Post 9/11 Climate: An Empirical Investigation of Consumer Ethnocentrism in The United States. International Journal of Advertising. 22, pp. 487-510.

Liu, C-H. (2009). The Development and Application of a Group Decision Model using Fuzzy Logic: The Case of Consumer Attitudes towards Risk. International Journal of Management Vol. 26 No. 2.

Maldonado, C., Susana, L., and Carranza, A. (2008). Heritage Pride and Advertising Effectiveness: The Mexican Case. Academy of Marketing Studies Journal, 12(2), 97-109.

Orth, U. and Firbasova, Z. (2003). The Role of Consumer Ethnocentrism in Food Product Evaluation. Agribusiness. 19 (2), pp. 137-153.

Pan, F. (2004). Selecting Oriented Alliance Partner to Assure Customer Satisfaction In international Markets. Journal of American Academy of Business, Cambridge. 4 (1/2), pg. 278.

Papatya, N. and Papatya, G. (2011). The New Reality of Competing: Strategic Marketing Intelligence and the Assessment of the Business Transformational Model Proposition American. Journal of Economics and Business Administration 3 (3): 479-489.

Pepper, M., Jackson, T., and Uzzell, D. (2011).An Examination of Christianity and Socially Conscious and Frugal Consumer Behaviors. Environment & Behavior, 43(2), 274-290.

Phau, I. and Chan, K.W. (2003). Targeting East Asian Markets: A Comparative Study on National Identity. Journal of Targeting, Measurement and Analysis for Marketing.12 (2), pp. 157-172.

Rawwas, M.Y. and Rajendar, K.N. (1996). The Influence of Worldmindedness and Nationalism on Consumer Evaluation of Domestic and Foreign Products. International Marketing Review. 13 (2), pp. 20-38.

Shankarmahesh M.N. (2006) Consumer Ethnocentrism: An Integrative Review of its Antecedents and Consequences International Marketing Review.23 (2), pp.146-172.

Sharma, S.H., Shimp, T.A. and Shin, J. (1995). Consumer Ethnocentrism: A Test of Antecedents and Moderators. Journal of Academy of Marketing Science. 23 (1), pp 26-37.

Strauss, D.A. (2011). Originalism, Conservatism, and Judicial Restraint.   Harvard Journal of Law & Public Policy. 34(1), pp.137-146.

Thelen, S. T. and Honeycutt, Jr. E. D. (2004). Assessing Identity in Russia between Generations Using the National Identity Scale. Journal of International Marketing. 12 (2), pp. 58-81.

Tonta, Y. (2005). Internet and Electronic Information Management. Information Services and Use. 25, pp.3-12.

Ulgado, F. (2002). Country-of-origin Effects on E-commerce. Journal of American Academy of Business. 2(1), p. 250, 4 ps.

Varul M.Z.(2008). After Heroism: Religion versus Consumerism. Preliminaries for an Investigation of Protestantism and Islam under Consumer Culture. Islam and Christian–Muslim Relations, 19(2), 237–255.

Wang, H., Wang, S. (2008): A knowledge management approach to data mining process for business intelligence, Industrial Management & Data Systems, Vol.108, No. 5, pp. 622-634.

Yu, J. and Albaum, G. (2002). Sovereignty Change Influences on Consumer Ethnocentrism and Product Preferences: Hong Kong Revisited one Year Later. http://webrouter.hud.ac.uk:7840/254746078/http://sciencedirect.com.ca.

Zadeh, L.A. (1965). 'Fuzzy Sets,' Information and Control, 8, 338–353.