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Analysis of Food Insecurity and Surveillance Based on the FANP Method in the northwest of Iran

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ABSTRACT: Food insecurity is frequent in both developed and developing countries, affecting from 5% to 25% of the general population. It has considerable health impacts on the physical, social, and psychological status of individuals in communities suffering from food insecurity. In this paper, we seek to use the Fuzzy analytical network process (FANP) for analysis of food insecurity surveillance and selecting the best strategies for improving it. This cross-sectional study was conductedon 300 subjects (132 male and 168 female) selected randomly in the Asadabadi area of the northwest of Iran.The method is validated using the structural validation approach. @JASEM

Keywords: Food insecurity, Analysis, Fuzzy Analytical Network Process (FANP).

The concept of household food insecurity includes problems with the quantity of available food, uncertainty about food supply, and experience of hunger in life (Alaimo et. all, 1998). Food insecurity is frequent in both developedand developing countries, affecting from 5% to 25% of the general population in different research reports (Bickel et. all, 2000). It has considerable health impacts on the physical, social, and psychological status of individuals in communities suffering from food insecurity. It may also affect the quality of life of households (Gulliford et. all, 2004).Various techniques and methods have been used to measure food insecurity in many countries (Gulliford et. all, 2006).The aim of this study was to document the epidemiologic features of food insecurity in the northwest region of Iran, and to evaluate the sensitivity and specificity of a short-form (six items) questionnaire for screening for food insecurity in the region.

To study and analyze these problems, we should be able to answer some basic questions: What insecurity type should be used? And also provides conditions for output quality and appropriate insecurity. What factors affected on the conditions of improvement of food insecurity, and how they can identify and provide the appropriate response to them?

It needs to select the best strategy based on the suitable method. There are various decision-making techniques. However, algorithm presented in this paper is based on the FANP; because of it can measure a relationship between the strategic factors that can make good such as AHP, ANP methods based on the independence factors. The AHP technique cannot measure to exist dependence between the factors, because the AHP compared to factors completely independent, and finally this method cannot effectively be an appropriate method considers assessing the effect of internal and environmental factors (Radimer et. all, 1990).

The study is set seven major sections; the second part presents related works. The third part presents research methodology. The forth part describes the proposed algorithm based on the FANP method. The fifth part is expressed results analysis in the northwest of Iran, and in the next sections, it will be discussed analysis of research findings and suggestions for future research results.

Related Works: Hunger and food security have been identified as national priorities that, in principle, should have particular relevance for nutrition education.1 For instance, the U.S. Department of Health and Human Services has adopted the goal of increasing the prevalence of food security among U.S. households as one of the health objectives for the nation for the year 2010. Maxwell et al. (2011) Measuring food insecurity: Can an indicator based on localized coping behaviors be used to compare across contexts? The Coping Strategies Index (CSI) was developed as a context-specific indicator of food insecurity that counts up and weights coping behaviors at the household level. It has proven useful to operational humanitarian agencies and researchers in measuring localized food insecurity, but to date has not been useful to compare the relative severity of different crises and has therefore has not been particularly useful for geographic targeting or resource allocation. This paper analyzes data from 14 surveys in crisisaffected or chronically vulnerable countries in Sub-Saharan Africa that incorporated the context-specific CSI. The paper identifies a sub-set of individual coping behaviors common to all surveys, whose severity is regarded as broadly similar by households across these studies. Data from these studies were re-analyzed using a reduced index constructed from only these behaviors. Correlations of this new index with other known food security indicators are similar to those of the complete, context-specific CSI. This suggests the possibility that an indicator based on these common behaviors could be used to compare the types of food security crises analyzed here across different contexts –

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particularly in Sub-Saharan Africa – to improve geographic targeting and resource allocation, according to the severity of crises. This new, more comparative indicator can be generated with no loss to the context-specific nature of the original CSI, which has proven useful for assessment and monitoring purposes. There are few universally valid indicators of food security that are applicable in crisis situations. Nutritional status, if properly measured, is widely accepted as comparable across different contexts. But while nutritional status can be one indicator of food security status, it may equally reflect elements of health status, care practices, water quality, and other determinants of nutrition (Young and Jaspars, 2006). Some analysts suggest that measuring actual food consumption at the household level by a 24-h recall should be the ''gold standard" by which other food security indicators are measured (Hoddinott and Yohannes, 2002; Weismann et al., 2006). But while 24-h recall data accurately reflects current consumption status, it does not capture other elements of the complex notion of food security. And the methodology is far too timeconsuming to be useful in the applications discussed above – early warning, assessment, targeting or monitoring – all of which are very time-sensitive.

Patterns of behavioral responses in relation to a food shortage have been documented previously by several researchers (Davies, 1996). Watts (1983) presented a sequence of options based on their reversibility and commitment of domestic resources. Modest dietary adjustments (such as eating less-preferred foods or reducing portion size), for example, are highly reversible strategies that do not jeopardize household assets. More extreme behaviors, such as sales of productive assets to purchase food, hold more long-term consequences for the household. As a food security situation worsens, households are more likely to employ strategies that are less reversible, and therefore represent a more severe form of coping and greater food insecurity (Corbett, 1988; Devereux, 1993).

The Coping Strategies Index is similar in many respects to other measures of food security but distinct in that it queries household behaviors directly, and factors in the severity of different behaviors. Given that no one ''gold standard" indicator has emerged, particularly for use in humanitarian emergencies, different measures of food security are needed for triangulation or complementary analysis. Attempts at developing and refining indicators of food access have revealed a number of critical considerations. First, food security is a ''managed process" with predictable patterns – people can foresee a food access problem before it arises and thus begin to alter behavior long before an actual crisis hits a household (Christiaensen and Boisvert, 2000). Second, with respect to coping strategies, it must be noted that some strategies do not necessarily reflect the same severity of food insecurity, nor are they equally acceptable to vulnerable households in different cultures (Coates et al., 2006a,b). To develop more broadly applicable measures of food security, adequate attention must be given to developing methods of translating or adapting measures from one context to another (Swindale and Bilinsky, 2006; Coates et al., 2006a,b; Webb et al., 2006; Maxwell et al., 1999). And third, although some progress has been made, the search for more broadly applicable measures of food security continues.

There is evidence that food insecurity, particularly transitory food insecurity, has been getting worse in Malawi. In 2001–2003 Malawi suffered a food crisis. This was manifested in a six-fold increase in food prices, which left around 3.5 million people food insecure. The crisis was the combined result of climatic shocks, mis-management of the country's strategic grain reserve, poor crop estimates and a chaotic delayed response in terms of maize imports (Stevens et al., 2002; World Development Movement, 2002).

METHODOLOGY

Research methodology of this paper has been based on the analytical and descriptive Research using FANP Method. This analytical and descriptive type research has been carried out using the questionnaire as the research tool for gathering the required data. Data's gathering involved both reference material and a questionnaire survey. Sampling was simple random sampling and the data-gathering instrument was the questionnaire. The author had already undertaken research in this field, which had stimulated the decision-making tchniques used to analyze this case study, based on FANP Method.

In June 2008 a request for interviews and questionnaires was sent to a number of the food Experts (80 persons, 30% Male and 70% Female, 70% over 10 year's experience) and the people (50 persons, 35% Male and 65% Female, 65% over 20 year's experience). Prior to the interview and fill the questionnaire, the author explained the purpose of the research and made it clear that this information would be in the public domain, so any confidentiality concerns could be noted. The interview and questionnaire, from December 2009 to April 2010, lasted ten hours per week. The interview and questionnaire were semi-structured in nature, starting with general questions on the Food Insecurity to put the respondent at ease. To ensure internal validity the interview and questionnaire were transcribed and sent to the experts for check that no commercially sensitive information had been included.

Fuzzy Analytical Network Process: The FANP is a generalization of the Like AHP, while the AHP represents a framework with a unidirectional hierarchical AHP relationship, the FANP allows for complex interrelationships among decision levels and attributes. The FANP feedback approach replaces hierarchies with networks in which the relationships between levels are not easily represented as higher or lower, dominant or subordinate, direct or indirect [5, 7, 9, 11]. Figure 1 presents Structural difference between hierarchy (a) and network (b).

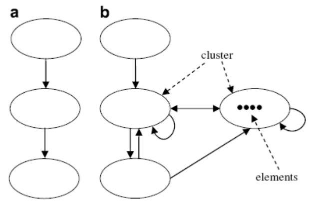

Fig 1: Structural difference between hierarchy (a) and network (b)

FANP is considered comprehensive and explanatory for multipurpose decision-making discussions and also for solving complex decision-making issues. Studies by Yüksel and Dagˇdeviren used ANP to select information system projects that are internally dependent. These studies saw no requirement for doing an ideal zero and one programming. Karsak**,** Partovi and Corredoira have used ANP in quality activity development [12, 14, 15]. A system with reflective state can be explained by a network. The structural difference between the hierarchy and the network is depicted in Figure 1. The existent element in each cluster can affect all or some of the other cluster elements. A network may contain main clusters, middle clusters, and final clusters. Arrows show the relationships in the network and their direction shows the dependence. The dependence among clusters can be named external dependence and the internal dependence among elements of a cluster can be called circle dependence [13, 15, 17]. The network model used in this research is presented in Figure 2.

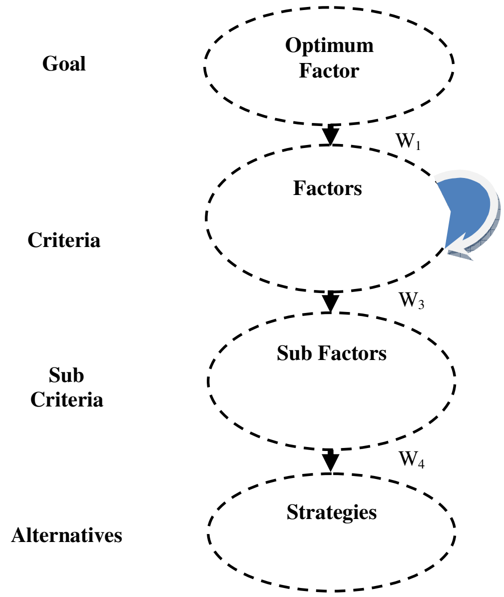

Figure 2: Network model structure

The proposed algorithm is derived as follows: **Step 1**: Determine the element sub-factors and strategic options according to sub-factors; **Step 2**: Establish the Triangular Fuzzy Numbers; **Step 3**: Assume that no dependencies among element factors exist, and then the importance degree of element factors is shown by the fuzzy scale; **Step 4**: Determine the element factors of the internally dependent matrix by the fuzzy scale, and consider other factors by schematic view and internal dependencies among them (W2 calculation); **Step 5**: Specify the internal dependencies' priorities, that is, calculate $w_{factors} = W_2 \times w_1$; **Step 6**: Specify the importance degree of element sub-factors using the fuzzy scale; **Step 7**: Specify the importance degree of sub-factors; **Step 8**: Specify the importance degree of strategic options, considering each sub-factor, on the fuzzy scale; **Step 9**: Calculate the final priority of strategic options derived from the internal relationships among element factors and Defuzzification its.

$$w_{alternatives} = W_4 \times w_{sub-factors\ (global)}$$

5. Case Study: This section presents an illustration of the proposed approach summarized in the previous section.The proposed algorithm is as follows: **Step 1**: First, the issue is depicted as a hierarchical structure, which contains the strategic options and sub-factors for the next calculations using FANP. (See Figure 3) The goal is chosen at the first level of the FANP Model and the element factors are determined at the second level. The third level contains the sub-factors. Furthermore, 3 strategic options are given in the fourth level. The strategic options are as follows: A-B: Appropriate Diet; A-C: Appropriate Exercise Programs; B-C: Appropriate treatment programs

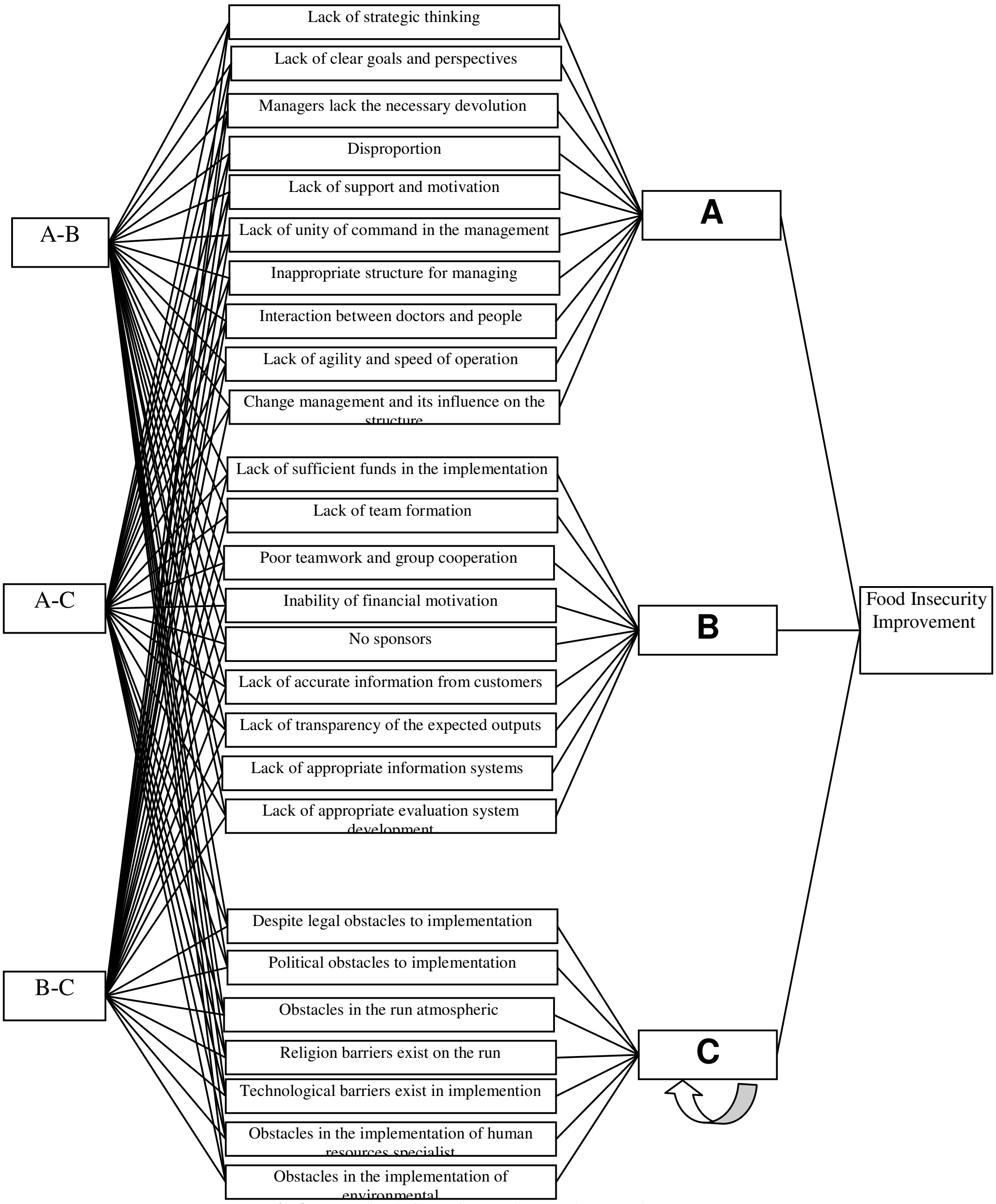

Fig 3: strategies influencing on the Food Insecurity

Step 2: Establish the Triangular Fuzzy Numbers. A triangular fuzzy number (TFN) is shown in Figure 4.

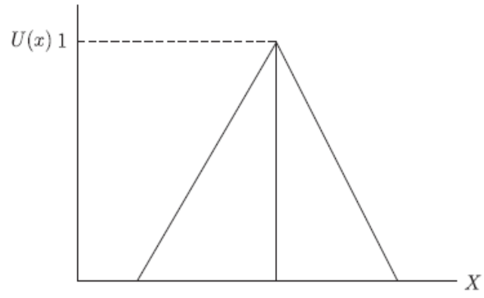

Fig 4: Triangular Fuzzy Numbers

Since each number in the pair-wise comparison matrix represents the subjective opinion of decision makers and is an ambiguous concept, fuzzy numbers work best to consolidate fragmented expert opinions. A TFN is denoted simply as (L, M, U). The parameters L, M and U, respectively, denote the smallest possible value, the most promising value and the largest possible value that describe a fuzzy event as shows in formulae (1) to (5). The triangular fuzzy numbers u_{ij} are established as follows:

$u_{ij} = (L_{ij}, M_{ij}, U_{ij})$, (1)

$L_{ij} \leq M_{ij} \leq U_{ij}$ and $L_{ij}, M_{ij}, U_{ij}\ \varepsilon[1/9, 9]$, (2)

$L_{ij} = \min(B_{ijk})$, (3)

$M_{ij} = n\sqrt{\prod B_{ijk}}$, (4)

and

$U_{ij} = \max(B_{ijk})$, (5)

Where B_{ijk} represents a judgment of expert k for the relative importance of two criteria C_i-C_j.

Step 3: Assume that there is no dependency among the element factors. Determine the factors' pair comparison matrix using the numerical scale of 1 to 9. (See results in Table 2) All the pair comparisons are completed by a team of experts. The pair comparison matrix (Table 2) is analysed using Expert Choice software and the following special vector is obtained. In addition, a final inconsistency coefficient is shown at the end of the table.

$$W_1 = \begin{bmatrix} A \\ B \\ C \end{bmatrix} = \begin{bmatrix} .528 \\ .140 \\ .332 \end{bmatrix}$$

Table 1: Pair wise comparisons (independent status)

Weight	C	B	A	Factors
0.528	2	3	1	A
0.140	1/3	1		B
0.332	1			C

CR=0.03

Step 4: The internal dependency among element factors is determined by comparing the effect of each factor on other factors. As mentioned in the preface, considering independence among the element factors is not always possible. Suitable and realistic results are obtained from the FANP technique and element analysis. An analysis of internal and external environment elements reveals the element factors' dependencies as shown in Figure 4. The results obtained from the special vectors are depicted in the last column of Tables 1 to 5. The internal dependency of the element matrix, based on the calculated relative importance weights, is shown by W2. While opportunities are only influenced by strengths, a pair comparison matrix cannot be formulated for the opportunities. Internal dependency of factors is defined in Figure 5.

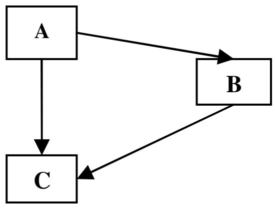

Fig 5: Internal dependency of factors

Internal dependency matrix of factor A is defined in Table 2.

Table 2: Internal dependency matrix of factor **A**

WEIGHT	C	B	A
0.667	2	1	B
0.333	1		C

CR=0.00

Internal dependency matrix of factor B is defined in Table 3.

Table 3: Internal dependency matrix of factor **B**

WEIGHT	C	A	B
0.9	9	1	A
0.1	1		C

CR=0.00

Internal dependency matrix of factor B is defined in Table 4.

Table 4: Internal dependency matrix of factor C

Weight	B	A	C
0.857	6	1	A
0.143	1		B

CR=0.00

$$W_2 = \begin{bmatrix} 1 \quad .9.857 \\ .667\ 1\ .143 \\ .133\,.11 \end{bmatrix}$$

Step 5: Priorities for internal dependencies among the factors are calculated as follows: The significant differences observed in the above results when compared with those in Table 1 are due to the lack of information about internal dependencies. Factor priority results including A, B, C have changed from 0.528 to 0.495, from 0.332 to 0.221, from 0.140 to 0.284; **Step 6**: Local priorities of sub-factors are calculated using the pair comparisons matrix. The priority vector is defined. According the priorities, it defines vector of sub factors.

$$W_{sub-fdactors-A} = \begin{bmatrix} 0.218 \\ 0.192 \\ 0.151 \\ 0.133 \\ 0.108 \\ 0.095 \\ 0.062 \\ 0.031 \\ 0.008 \\ 0.002 \end{bmatrix}, \quad W_{sub-fdactors-B} = \begin{bmatrix} 0.297 \\ 0.196 \\ 0.148 \\ 0.137 \\ 0.117 \\ 0.082 \\ 0.023 \end{bmatrix}, \quad W_{sub-fdactors-C} = \begin{bmatrix} 0.207 \\ 0.175 \\ 0.135 \\ 0.126 \\ 0.108 \\ 0.096 \\ 0.076 \\ 0.044 \\ 0.033 \end{bmatrix}$$

Step 7: General priorities of the element sub-factors are calculated by multiplying the internal dependency priorities, obtained in Step 4, by the local priorities of element sub-factors, obtained in Step 5. The results are depicted. Vector $w_{\text{sub-factors (global)}}$ which is obtained from the general priority amounts in the last column of table.

$$W_{sub-fdactors-GLOBAL} = \begin{bmatrix} 0.107 \\ 0.095 \\ 0.075 \\ 0.066 \\ 0.053 \\ 0.047 \\ 0.031 \\ 0.016 \\ 0.004 \\ 0.001 \\ 0.084 \\ 0.055 \\ 0.042 \\ 0.038 \\ 0.034 \\ 0.024 \\ 0.007 \\ 0.046 \\ 0.039 \\ 0.030 \\ 0.028 \\ 0.024 \\ 0.021 \\ 0.017 \\ 0.010 \\ 0.007 \end{bmatrix}$$

Step 8: The degree of strategic options' importance is calculated from each element's sub-factor viewpoints. Special vectors are calculated from the analysis of this matrix and matrix W4.

$$W_4 = \begin{bmatrix} 0.653 & 0.578 & 0.637 & 0.472 & 0.253 \\ 0.282 & 0.350 & 0.051 & 0.453 & 0.107 \\ 0.065 & 0.072 & 0.312 & 0.075 & 0.640 \end{bmatrix}$$

$$\begin{matrix} 0.078 & 0.285 & 0.774 & 0.444 & 0.148 & 0.573 & 0.547 & 0.118 & 0.450 \\ 0.137 & 0.577 & 0.161 & 0.508 & 0.571 & 0.238 & 0.223 & 0.335 & 0.250 \\ 0.785 & 0.138 & 0.065 & 0.048 & 0.281 & 0.189 & 0.230 & 0.547 & 0.300 \end{matrix}$$

$$\begin{matrix} 0.578 & 0.637 & 0.472 & 0.253 & 0.078 & 0.285 & 0.774 \\ 0.350 & 0.051 & 0.453 & 0.107 & 0.137 & 0.577 & 0.161 \\ 0.072 & 0.312 & 0.075 & 0.640 & 0.785 & 0.138 & 0.065 \end{matrix}$$

$$\begin{matrix} 0.444 & 0.148 & 0.573 & 0.547 & 0.118 \\ 0.508 & 0.571 & 0.238 & 0.223 & 0.335 \\ 0.048 & 0.281 & 0.189 & 0.230 & 0.547 \end{matrix} \Bigg]$$

Step 9: Finally, the general priorities of strategic options are calculated considering the internal dependencies of element factors, as follows:

$$w_{alternatives} = \begin{bmatrix} A-B \\ A-C \\ B-C \end{bmatrix} = W_4 * w_{sub-factors(global)} = \begin{bmatrix} 0.456 \\ 0.269 \\ 0.275 \end{bmatrix}$$

The results of FANP analysis show that the most important strategy for the food insecurity is strategy A-B or Appropriate whose score is 0.456.

DISCUSSION

This study faced many challenges in its model validation test. The first is that the FANP model's factors are not naturally quantitative. FANP is a technique for solving multi-criteria decision making by using the dependence among quantitative and qualitative factors. However, it is not always possible to apply numerical and quantitative amounts to elements in decision-making. It is also that for each calculation, different amounts resulted. This may be due to the different viewpoints among the experts who evaluated the matrix. Thus, it seems impossible to obtain similar amounts based on the data obtained from different studies. These limitations are exacerbated by the nature of decision making. It is natural that in different circumstances, there are different priorities. It should be noted that the existent differences among the pair comparison amounts, which are due to the differences in expert viewpoints, are not sufficient reason for rejecting the proposed model's validity in FANP discussions [Chung, Lee and Pearn 2005; Expert Choice 2000; Ngai 2003]. Another problem is that the validity of this model has not been tested using the latest data and that is because those data are available only to special managers. The comparison matrix which is the input for the proposed model was composed under definite conditions; hence, results may differ due to the pair comparison matrix's composition in different time periods [Saaty 1980]. This model may be improved as the factors and sub-factors keep changing. Each management team should apply these strategies to the model according to the strategic factors in play. Second, the amount of dependence among factors and sub-factors may vary based on the management type. For example, in The Tehran Provice, only the dependence among important element factors is evaluated. The inconsistent ratio resulting from the pair comparison matrix also conorganizations this model. The inconsistent ratio or CR is based on the inconsistency index and Random index. Inconsistency index or CI can be obtained through the following formula:

$$CI = (\lambda_{\max} - n)/(n-1)$$

where $\lambda_{\max}$ is the highest special amount and n is the matrix dimension. Inconsistency ratio (CR) is composed of two parameters: inconsistency index (CI) and Random index (RI). The relationship between RI and n is as follows:

RI = 1.98 * [(n – 2) / n]

Where 1.75 is the ratio of average amount of all numbers for n=3 till n=15, each having been multiplied by (n-2)/n. The calculated amount for the inconsistency ratio in FANP should not be less than 0.1. The inconsistency ratio of the pair comparison matrix is calculated using Expert Choice. All inconsistency ratio amounts are less than 0.1. The proposed model is the first of its kind and is hence considered unique.

The results were re-rating of the experts who confirmed that 79.5 percent, and it suggest for reliability. Validity of the model is used the Cronbach alpha value was 88.2 percent, which indicates validity of the model.

Conclusion: We have defined and classified the effective factors of the Appropriate Diet and analysed them using FANP. The Appropriate Diet is one of the most powerful elicitors of subjective emotion. It presents the best strategy influence on Appropriate Diet improvement. This cross-sectional study was conductedon 300 subjects (132 male and 168 female) selected randomly in the Asadabadi area of the northwest of Iran.The method is validated using the structural validation approach.

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