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Effects of Environmental Scanning and Structural Analysis Systems on Long-Term Strategic Planning: Syrian Wheat Production as a Case Study

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Abstract: Environmental scanning is a milestone at the start of futures studies and strategic planning process. It must be done collectively and as participatory as possible to explore, create, and test both possible and desirable futures to capture opportunities of the futures images, trying to optimize it, and at the same time to avoid or reduce the risks of future threats. Internal analysis focuses on the strengths and weaknesses of an organization, while external analysis focuses on the threats and opportunities that may suddenly happen in the future.

These two types of analysis provide an inventory of all variables / factors or events / drivers, internal and external that characterizes the system. But this is not enough for long-term strategic planning, the issue is not really planning, but rather the manner in which planning is executed.

So advanced analysis should be done to study the direct and indirect relations among these trends, issues, variables / factors.

As the vector of key variables is extracted with relations (influence, dependency) in mind, The impact of each of these key variables on each other must be taken into account relative to the system under study; CIA (Cross-Impact-Analysis) method is used to study such impacts. Future studies and forecasting methods need to benefit from this analysis to focus on the effects of these unprecedented future events. This paper introduces such work by integrating the results of strategic planning tools with futures studies methods and this could be essential for advanced analysis.

Keywords: Environmental scanning, PESTEEL analysis, SWOT analysis, MICMAC method, CIA method.

1. Introduction:

Strategic planning process defines an organization's long-term direction in terms of a mission, visions, goals and objectives, and programs or planned commitments of resources. Good performance of an organization is the result of the correct interaction with its internal/external environment and of the ability to adapt to outside environment and to constitute a primary mode of organization learning. Since the environment is not controlled; the operation of an organization and the daily decision and actions is affected by changing factors: both external

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and internal. The uncertainty in the environment has been characterized on the basis of the variability of emerging trends and potential issues [1]. Internal analysis is done using internal factor evaluation (IFE) and constitutes internal analysis of SWOT analysis matrix. However, external analysis is done using external factor evaluation (EFE). EFE actually is PESTEEL analysis, and external analysis part of SWOT analysis matrix. IFE and EFE are oriented by real-time Delphi (RT-Delphi) as an expert-oriented analysis questionnaire to assign probabilities, weights, rating, and reduce uncertainties. RT-Delphi plays an essential role as it permits participation among different experts, estimating the subjective probabilities of the various key factors/events for the future through an organized questionnaire to study the system of our interest. Future studies represent a multi-disciplinary research aim to study potential change, issues, trends, mega trends, driving forces, emerging counter forces and uncertainties in all major areas of life to find the interacting dynamics that are creating the future. This is performed by employing a wide range of methodologies, either purely quantitative, purely qualitative or combination of both to cover the diverse and different views of the future. Future visions can help generate long-term policies, strategies, and plans, which help bring desired and likely future circumstances into closer alignment [2], [3].

Godet's structural analysis method [4], called MICMAC (Impact Matrix Cross-Reference Multiplication Applied to a Classification), method is used as a collective process to linkup ideas of multiple participants who represent internal personnel and outside experts in the domain under study. These participants have the possibility to describe the system using an influence matrix which identifies the various variables/elements and describes the relation between them. Through the study of such relations, the method can uncover which variables are essential for the system, so a vector of key variables is extracted. This new list of key variables again must be considered using Chao's new look at cross-impact analysis method [5], which combines the level of anticipated future impact and their probability of occurrence. Thus, both are factors in the analysis and combined results will serve as a basis for evaluating the future development, and hence the conditional probabilities of events and its impact are WRT-Delphi-Oriented results. Finally, a vector n of expected impact is extracted and this vector could be useful for advanced stage in analysis of a system of our interest.

This paper concentrates on the following methods:

- WRT-Delphi questionnaire.
- External Factor Evaluation Matrix (EFE).
- Internal Factor Evaluation Matrix (IFE).
- PESTEEL analysis matrix.
- SWOT analysis matrix.
- Structural analysis, MICMAC matrix.
- Cross-Impact-Analysis.

2. Weighted Real-Time Delphi Questionnaire (WRT-Delphi)

Traditional Delphi method based on a number of sequential rounds of questionnaires for eliciting knowledge from a group of experts, who are anonymous to each other. After each round a feedback of statistics such as median, group judgments is given in addition to arguments, variables, trends, counter forces [6, 7]. The rationale behind the Delphi method is to address and overcome the disadvantages of traditional methods of consultation by large-scale participators, particularly those related to group dynamics.

WRT-Delphi analysis is actually a round-less RT-Delphi technique enhanced by weighting the experts' opinions according to some attributes (experience, number of participating in the

study), and done online. It is essential in eliciting knowledge mechanism, listing variables, factors, trends, forces, evaluating the probabilities of events occurrence.

It provides statistical information based on the following :

- The analysis technique is a matrix in which rows represent alternatives strategies, and columns represent previously stated criteria which in fact are weighted criteria.
- Each cell in the matrix has its own statistics which in turn dynamically updated online and express the degree to which rows meet the columns according to a weighted list.

WRT-Delphi is a good results-based and expert-based questionnaire, and it could be combined with other methods such as MICMAC, CIA, IFE, EFE, PESTEEL, and SWOT to make these methods as participatory as possible.

3. Environmental Scanning

3.1 External Factor Evaluation Matrix (EFE)

This method is a strategic management tool used to scan the external environment of the system under study to extract all the variables, drivers, events, factors, trends that subjected to *Political, Economical, Socio-cultural, Technological, Ecological, Ethical, and Legal* external factors which in turn factors of PESTEEL analysis, and also subjected to threats, and opportunities of SWOT analysis. This matrix could be integrated with WRT-Delphi and hence the EFE matrix is oriented by WRT-Delphi to be WRT-Delphi-Oriented-EFE matrix. This matrix is conducted online and consists of the following five steps as in [8]:

- ***List factors***: a list of external factors divided into two groups: opportunities, threats.
- ***Assign weights***: assign a weight to each factor, the value should be between 0 and 1 (or between 10 and 100). Zero means the factor is not important, 1 or 100 means that the factor is more influential and critical one. The total sum of all weights should equal to 1 or 100.
- ***Rate factors:*** rating should follow a rating scale between 1 and 4 or any other scale. This rating indicates how effective the firm's current strategy responds to the factor; 1: a major threat, 2: a minor threat, 3: a minor opportunity, 4: a major opportunity.
- ***Multiply weights by rating:*** each factor weight is multiplied with its rating to calculate the weighted score for each factor.
- ***Total weighted scores:*** sum the weighted scores of the all factors. Fig. 1. Illustrates such matrix.

WRT-Delphi-Oriented-EFE matrix

Opportunities	Weight	Rating	Weighted Score
O1	$W_{11}(O_1)$	R1(O1)	$W_{11}(O_1)$*R1(O1)
O2	$W_{21}(O_2)$	R2(O2)	$W_{21}(O_2)$*R2(O2)
O3	$W_{31}(O_3)$	R3(O3)	$W_{31}(O_3)$*R3(O3)
. .	. .	. .	. .
On	$W_{n1}(O_n)$	Rn(On)	$W_{n1}(O_n)$*Rn(On)
Sum Of opportunities Weighted Score	$Sum(O) = \sum_{i=1}^{n} Wi1(Oi) * Ri(Oi)$		
Threats	**Weight**	**Rating**	**Weighted Score**
T1	$W_{11}(T_1)$	R1(T1)	$W_{11}(T_1)$*R1(T1)
T2	$W_{21}(T_2)$	R2(T2)	$W_{21}(T_2)$*R2(T2)
T3	$W_{31}(T_3)$	R3(T3)	$W_{31}(T_3)$*R3(T3)
. .	. .	. .	. .
Tn	$W_{n1}(T_n)$	Rn(Tn)	$W_{n1}(T_n)$*Rn(Tn)
Sum Of threats Weighted Score	$Sum(T) = \sum_{i=1}^{n} Wi1(Ti) * Ri(Ti)$		
TOTAL WEIGHTED SCORE	100%		***SUM(O)+SUM(T)***

Fig. 1. WRT-Delphi Oriented EFE matrix

3.2 Internal Factor Evaluation Matrix (IFE)

This matrix is a strategic management tool used to scan the internal environment of the system under study, and to extract all the events, factors, variables, trends that subjected to strengths and weaknesses internal factors of SWOT analysis. Like EFE matrix could be created using the five steps of EFE, matrix: extracting internal factors, weight the factors, rating factors, multiplication, and sum. Fig. 2 illustrates such matrix. IFE, matrix is oriented by WRT-Delphi to be WRT-Delphi-Oriented-IFE matrix.

3.3 PESTEEL Analysis Matrix

As mentioned above, WRT-Delphi Oriented EFE matrix is actually PESTEEL analysis oriented by WRT-Delphi and is performed online. It is good practice to perform the PESTEEL and then use the results in the opportunities as advantages and in the threats section of the SWOT analysis to make contingency plans. PESTEEL as its EFE, matrix also could be oriented by WRT-Delphi method to become WRT-Delphi-Oriented-PESTEEL analysis. The factors / variables of this analysis should be grouped into the following groups:

- Political, government, business trends.
- Economic variables.
- Social, cultural, demographic.
- Technological factors.
- Ecological factors.
- Ethical factors
- Legal factors

WRT-Delphi-Oriented-IFE matrix

Strengths	Weight	Rating	Weighted Score
S1	$W_{11}(S_1)$	R1(S1)	$W_{11}(S_1)$*R1(S1)
S2	$W_{21}(S_2)$	R2(S2)	$W_{21}(S_2)$*R2(S2)
S3	$W_{31}(S_3)$	R3(S3)	$W_{31}(S_3)$*R3(S3)
. .	. .	. .	. .
Sn	$Wn_1(S_n)$	Rn(Sn)	Wn_1(Sn)*Rn(Sn)
Sum Of strengths Weighted Score	$Sum(S) = \sum_{i=1}^{n} Wi1(Si) * Ri(Si)$		
Weaknesses	**Weight**	**Rating**	**Weighted Score**
W1	$W_{11}(W_1)$	R1(W1)	$W_{11}(W_1)$*R1(W1)
W2	$W_{21}(W_2)$	R2(W2)	$W_{21}(W_2)$*R2(W2)
W3	$W_{31}(W_3)$	R3(W3)	$W_{31}(W_3)$*R3(W3)
. .	. .	. .	. .
Wn	$Wn_1(W_n)$	Rn(Wn)	$Wn_1(W_n)$*Rn(Wn)
Sum Of weaknesses Weighted Score	$Sum(W) = \sum_{i=1}^{n} Wi1(Wi) * Ri(Wi)$		
TOTAL WEIGHTED SCORE	100%		***SUM(S)+SUM(W)***

Fig. 2. WRT-Delphi Oriented IFE matrix

3.4 SWOT Analysis Matrix

SWOT analysis is strategic planning tool consists of WRT-Delphi-Oriented-IFE matrix, and WRT-Delphi-Oriented-EFE matrix to list all variables, drivers, trends, factors that could be divided into four groups of strengths, weaknesses, opportunities, threats. This WRT-Delphi-Oriented-SWOT matrix and all the matrices above provide us with a list of variables, events, factors, trends that is very important to another kind of analysis which study the relations among these variables, the influence, dependency and also the direct and indirect relations and this in its turn is the subject of structural analysis (MICMAC) method.

4. Structural Analysis

4.1 Structural Analysis MICMAC method

By integrating the structural analysis (*MICMAC*) method with WRT-Delphi method we can get WRT-Delphi-Oriented-MICMAC method, which will be used to study the system or problem domain for:

- Listing all variables/factors.
- Finding the direct and indirect classifications among variables.
- Extracting the essential events and key variables/factors.

The three points above are done using the expertise and participation of the participators or domain experts who can fill the matrix of traditional structural analysis matrix over a sufficient period of time determined by domain analysts, in the questionnaire's design step.

4.1.1 Listing all variables / factors

This must be done as exhausted and participatory as possible to extract all the variables/factors, trends, drivers, events that affect our system. A vector of (*n)* variables / factors is extracted. Actually this phase is the result of the previous mentioned matrices, and constitutes the milestone of the advanced analysis of MICMAC method.

4.1.2 Finding the direct and indirect classifications among variables

In this phase a matrix with dimension *n x n* is defined. The influence between any pair of variables is given by the experts. This explains the need to integrate MICMAC method with WRT-Delphi method so the name of the method could be WRT-Delphi-Oriented-MICMAC method. This matrix is known as Matrix of Direct Influence (MDI). Each cell of the matrix states the influence of one variable / factor i over some other variable/factor j, measured in a 4 grade scale:

- 0 if variable i has no influence on variable j.
- 1 if variable i has a low influence on variable j.
- 2 if variable i has a medium influence on variable j.
- 3 if variable i has a strong influence on variable j.
- 4 if variable i has a potential relation with variable j. If the matrix contains potential influence, it is ignored and taken as 0 in summation. A potential relation means that the influence is not clear but may become notorious under some condition.

Table 1 illustrates such a MDI matrix for 10 variables/factors. The main diagonal of the matrix is always 0 because a variable does not have influence on itself. This matrix is important to show the ***direct influence*** (*Rf*) of variable *i* over the rest variables computed as the sum of all the values of row *i* of the MDI matrix. In the example above the variable F10 has a high summation of 10 this means that F10 more influence than other variables.

Table 1. MDI matrix for 10 variables

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	$\sum_{j=1}^{10} Fj$	*Rank*
F1	0	1	0	2	0	0	1	3	0	0	7	2
F2	0	0	1	0	1	0	0	0	0	0	2	6
F3	0	2	0	0	3	1	0	0	0	0	6	3
F4	0	1	1	0	0	0	1	0	0	0	3	5
F5	0	0	0	0	0	0	0	1	0	0	1	7
F6	1	0	0	0	0	0	2	0	0	0	3	5
F7	0	0	0	0	0	1	0	0	0	1	2	6
F8	0	0	0	0	0	0	0	0	0	0	0	8
F9	0	2	0	1	0	0	0	0	0	1	4	4
F10	1	3	2	1	0	0	2	1	0	0	10	1
$\sum_{i=1}^{10} Fi$	2	9	4	4	4	2	6	5	0	2		
Rank	5	1	4	4	4	5	2	3	6	5		

Another measure could be extracted from MDI matrix, the ***direct dependence*** (*Rd*) of a variable *i* of the rest also is computed as the sum of all the values of column *j*.
After summation over rows and over columns, ranking the variables by rows results in influence ranking, and ranking them by columns results in dependence ranking.
Two rankings are built by sorting the variables according to their influence and their dependence. Ranking is a first indicator of the importance of each variable, Therefore each variable has two different measures associated with it: ***direct influence, direct dependence***.

But what about the indirect relations among these variables/factors?. MICMAC method doesn't stop in finding the direct relations, but it is used again to find the indirect relation by raising the MDI matrix to the power of 2, 3, 4, 5, and so on to reach a stable order of the impact variables/factors when the matrix only consists of stable results and thus no classification can be done. The result is the numbers of indirect impact paths. The algorithm to calculate indirect influences and indirect dependences of the variables, which is an iterative process, could be done in two steps as in [9]:

1) Initialization step:

Let ***Rf*** and ***Rd*** be the influence and dependence rankings obtained with the direct method.

- Initialize ***M*** to be the original ***MDI*** matrix.

2) Iteration:

- Do ***M = M * MDI*** and compute the new influence and dependence rankings ***Sf*** and ***Sd.***
  - Compare ***Sf*** with ***Rf*** and ***Sd*** with ***Rd.***
  - If both comparisons match, finalize.

    Otherwise, update the old rankings:
    - let ***Rf = Sf*** and let ***Rd = Sd*** and go to ***step 2*** again.

4.1.3 Extracting the essential events and key variables / factors

After reaching the final matrix, rankings by the rows and by the columns are done to obtain a list of variables ranked according to their indirect influence, and dependence. Then influence/dependence chart is drawn and this is illustrated in details in the case study. A list of key variables is extracted according to final rank, and here an advanced analysis is used to benefit from such a key variables vector.

5. Cross Impact Analysis (CIA)

From the previous analysis a vector of key variables with relations in mind is extracted. But what is the magnitude of impact of these variables, what is the conditional probability of these events. Chao's new look at cross-impact analysis method is used [5] which combines the level of anticipated future impact and their probability of occurrence, so that both are factors in the analysis. The combined results will serve as basis for evaluating the future developments. In this paper the new cross-impact analysis method is combined with WRT-Delphi and hence the conditional probabilities of events and their impacts are extracted by WRT-Delphi-oriented-CIA matrix. In this method:

- The experts first asked to appreciate the initial probability of events' occurrence and this will be formed as initial probability vector.
- The experts second asked to consider the conditional probability of occurrence or non-occurrence of other events and hence cross-impact analysis must be taken into account with respect to online weighted experts opinions.

- Third the experts asked to consider the cross-impact matrix That is, the matrix represents "if the column events were to occur, what is the magnitude of the impact to the row events?", so the experts asked to consider an expected impact of event *i* given the probability of occurrence of each and all events. This vector contains (*n*) entries. It represents the expected impact of each event, and this vector will be used later. Impacts score may be from 1 to 5 or from -5 to 5 or any other score.

Judgments about the values, probabilities, and impacts of variables should be included in CIA matrix. Statistics should be done to extract the final matrix to be studied in advanced analysis.

6. Case Study: Syrian Wheat Production

"Syria has been essentially self-sufficient in wheat production for the past 20 years, with the infrequent exception of seasons when severe drought prevails (ex. 2008). Wheat self-sufficiency has been a major policy objective of the government, which over the years encouraged the expansion of sown area and the development of increased irrigation infrastructure to ensure production growth kept pace with gradually increasing domestic consumption. Wheat is the most important staple food commodity in the country and is consumed primarily as bread. It is also the country's only strategic food security commodity, and is treated accordingly. Food crop cultivation is limited to an arc of land stretching along the western Mediterranean coast and eastward following the northern border with Turkey, where prevailing weather patterns provide between 150-700 millimeters (6-28 inches) of autumn and winter rainfall. Wheat is the most important cereal grain grown, encompassing nearly 60 percent of total cultivated agricultural land.

Wheat is grown throughout the agricultural belt in a wide variety of microclimatic environments, under both irrigated and rainfed conditions. Rainfed wheat acreage is the majority of total sown area, and averages around 1.0 million hectares per year. Irrigated wheat is cultivated in virtually every province; however total acreage is insufficient to ensure national wheat self-sufficiency. Wheat is the single largest consumer of irrigation water in the country, accounting for roughly 60 percent of all land devoted to annual crops. Approximately two-thirds of Syria is too arid for agriculture, being either desert or covered by sparse native grasslands. The uprising against the government in Syria is entering its 24th month. The unknown element in the situation is how the rural community which is dispersed across the extent of the country's grain growing regions is coping, and whether the conflict will in any way affect their ability to successfully harvest and market the 2012 winter grain crop. Syria's economy is under extreme pressure owing to coordinated international sanctions (U.S., European, Japan, and Arab-Turkish) which include an embargo on oil exports, seizure of foreign-held Syrian assets, and severe restrictions on trade, financial transactions, and investment." [10]

In fact this paper studies the Syrian wheat production using the previous matrices to extract all factors, variables, trends, events, issues that affect wheat production. Our study could be divided as follows:

- Environmental scanning and strategy formulation.
- List all the variables / factors.
- Identify the key variables.
- Studying the impact of these key variables.

This study depended on interviews with experts and some studies from the internet [10].

6.1 Environmental Scanning and Strategy Formulation

This phase must be done as exhausted as possible to list all the variables using WRT-Delphi-Oriented-EFE matrix, WRT-Delphi-Oriented-IFE matrix, WRT-Delphi-Oriented-PESTEEL analysis, WRT-Delphi-Oriented-SWOT analysis.

6.1.1 WRT-Delphi-Oriented-EFE matrix

This matrix shows the factors of external analysis of PESTEEL, and SWOT analysis, the matrix is as shown in Fig.3. This matrix is the opportunities and threats that could be emerge in the future and which have important effects on wheat production. This matrix is a good tool used to visualize and prioritize the opportunities and threats that a Syrian wheat production is facing. It is acting as an early warning system; facilitating risk management; improving resources allocation; increasing managerial awareness of environmental changes; focusing on the primary influences of strategic change [11, 12].

External factor Opportunities	Weight	Rating	Weighted Score
O1: Bridging yield gaps	0.07	3	0.21
Q2: enhancing wheat production at low wheat production places	0.04	3	0.12
O3: increasing information technology	0.05	4	0.2
O4: increasing agro-industries related to wheat production	0.05	3	0.15
O5: development of new technologies	0.06	3	0.18
O6: enhancing governmental policies for agriculture	0.05	3	0.15
O7: Increase the role of agriculture in national development	0.05	3	0.15
O8: The growth of population	0.06	4	0.24
O9: Producing sufficient amount of soft wheat to meet the mills requirements	0.04	3	0.12
Total	**0.47**		**1.52**
Threats	**Weight**	**Rating**	**Weighted Score**
T1: Global climate change	0.07	1	0.07
T2: Deteriorating soil health	0.04	2	0.08
T3: New diseases and insect pests	0.05	2	0.1
T4: Water scarcity	0.05	1	0.05
T5: Population pressure	0.05	2	0.1
T6: Global priving and subsidy ppolices	0.05	2	0.1
T7: Production risk	0.04	2	0.08
T8: Political change	0.06	1	0.06
T9: Incoherent government policies	0.06	2	0.12
T10: Economical instability in Syria	0.06	2	0.12
Total	**0.53**		**0.88**
Total weighted score	**1**		**2.4**

Fig. 3. WRT-Delphi Oriented EFE matrix of Syrian wheat production

6.1.2 WRT-Delphi Oriented IFE matrix

This matrix shows the factors of Internal analysis of SWOT analysis, the matrix is as shown in Fig. 4. This matrix is the strengths and weaknesses which have important effects on wheat production**.** As shown in Figs. 3, 4 weights, and rating of variables are useful to know what kind of strategy should be followed. These strategies actually are essential for SPACE (Strategic Position and Action Evaluation) matrix strategic management method. SPACE matrix is used to analyze the system, to determine what type of strategy (aggressive, conservative, defensive, competitive) an organization should undertake, and assessing strategic alternatives. This gives a good indicator about the future, and could be a basic step for advanced analysis.

Internal factor	Weight	Rating	Weighted Score
Strengths			
S1: High quality land	0.04	3	0.12
S2: availability of labor forces involved in production	0.04	3	0.12
S3: availability of water for riverside situation	0.05	4	0.2
S4: New technology	0.04	4	0.16
S5: National farming systems	0.03	3	0.09
S6: Genetic diversity and improved seeds	0.04	3	0.12
S7: Precense of strong unions and cooperatives	0.04	4	0.16
S8: Suitable varieties for diverse agro-climatic conditions	0.03	3	0.09
S9: Suitable climatic conditions for growing wheat	0.05	3	0.15
S10: trained human resources and well developed infrastructure	0.05	3	0.15
Total	**0.41**		**1.36**
Weaknesses	**Weight**	**Rating**	**Weighted Score**
W1: Narrow genetic base	0.04	2	0.08
W2: Lack of resources	0.04	2	0.08
W3: Lack of reliable data and information on organic agriculture	0.04	1	0.04
W4: Need to match international standards	0.08	2	0.16
W5: Poor local market opportunities and infrastructure	0.08	1	0.08
W6: High cost of production	0.07	2	0.14
W7: Inadequate linkages between research and industries	0.06	2	0.12
W8: Lack of added value	0.04	2	0.08
W9: Absence of procurement based on quality	0.04	2	0.08
W10: Poor image marketing	0.03	2	0.06
W11:Poor commercialization initiatives	0.07	2	0.14
Total	**0.59**		**1.06**
Total weighted score	**1**		**2.42**

Fig. 4. WRT-Delphi Oriented IFE matrix of Syrian wheat production

6.1.3 Strategic Position and Action Evaluation (SPACE) Matrix

This matrix focuses on strategy formulation and can be used as a basis for SWOT analysis to determine the kind of strategy that should be pursued. SPACE matrix is divided into four quadrants; each quadrant suggests different type of strategy [8]:

- Aggressive
- Conservative
- Defensive
- Competitive

SPACE matrix has two axes: horizontal axis for internal analysis factors (Weaknesses, Strengths) and vertical axis for external analysis factors (Threats, Opportunities). The SPACE matrix is constructed by plotting calculated values (total weighted scores) for internal and external factors on the X and Y axis. For Syrian wheat production total weighted score of external factors is 2.4, this value is plotted on Y axis, and total weighted score of internal factors is 2.42, which is plotted on X axis. Then the intersection between these two points indicates the type of strategy that should be pursued. Fig. 5 illustrates the SPACE matrix, which indicates that the government should pursue defensive strategies. This step is not only a basic step toward constructing the SWOT matrix but also a basic indicator for further analysis.

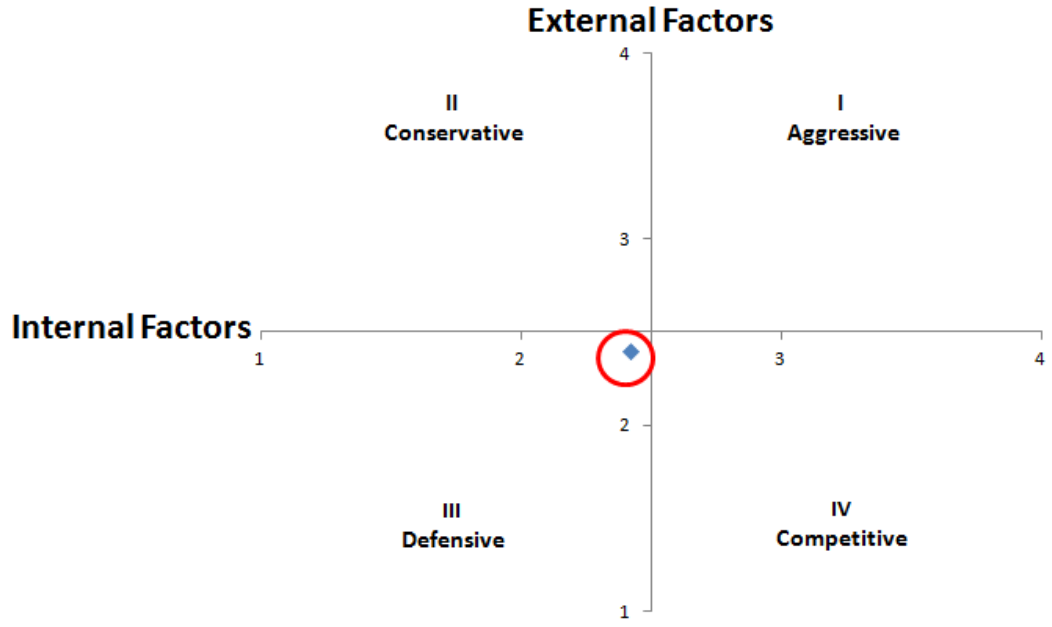


Fig. 5. SPACE matrix

6.1.4 SWOT analysis matrix for Syrian wheat Production

What are the benefits that one could have from previous results to construct SWOT matrix of Syrian wheat production?
Since, SWOT matrix focuses on four strategic groups, which are:

- How strengths are used to capture the advantages of opportunities?
- How weaknesses are reduced by capturing the advantages of opportunities?
- How strengths are used to reduce the impact of threats?
- How weaknesses are addressed in regard of these threats?

As the government should pursue defensive strategy, Fig. 6. illustrates such strategy.But which one of these 11 strategies should be selected?. Quantitative Strategic Planning Matrix (QSPM) gives an answer to this question.

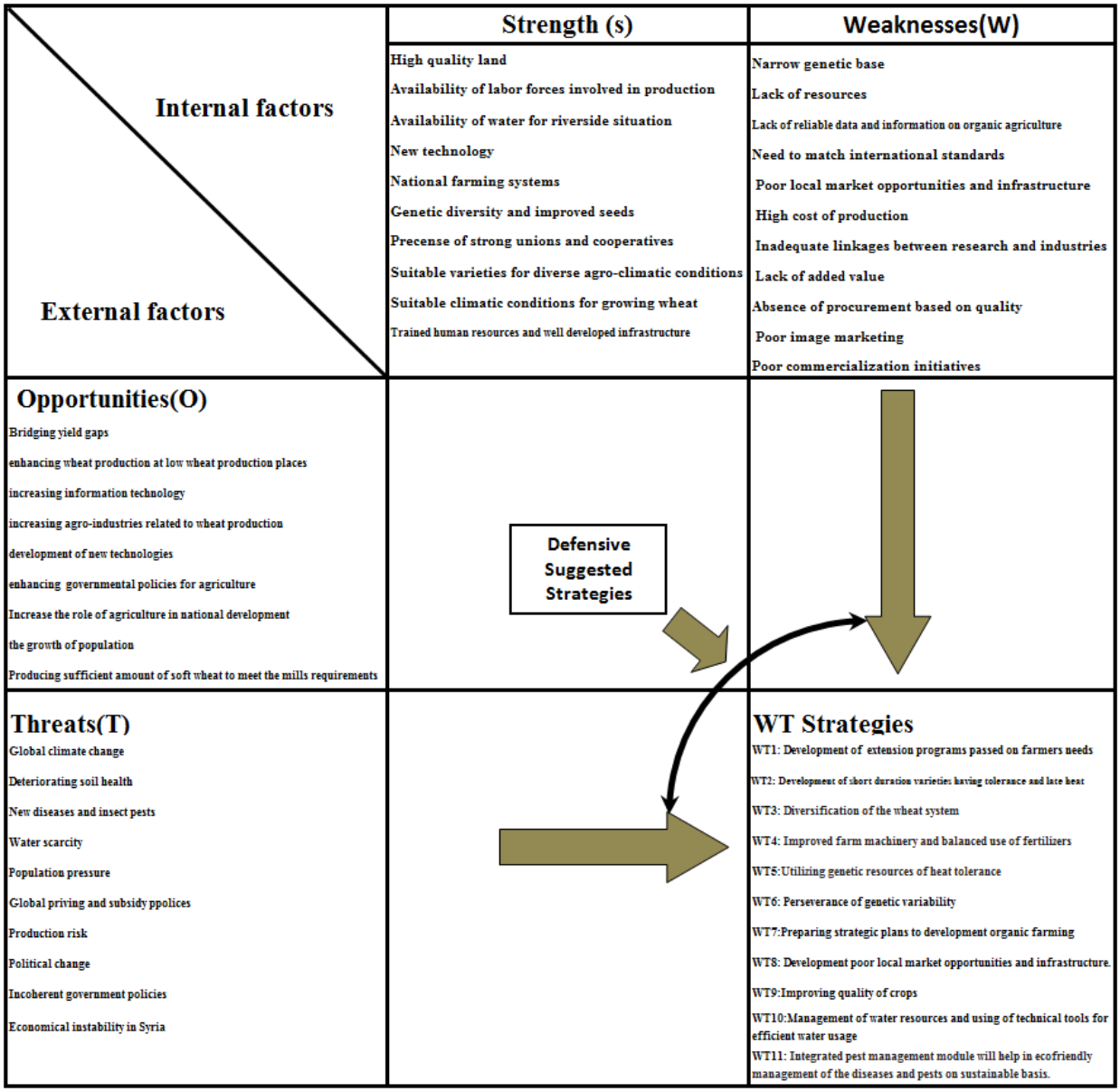


Fig. 6. SWOT Matrix for Syrian Wheat Production

But this is not enough, comprehensive work should be done to take into account the relations among these factors, and how could these factors affect the future images and scenarios of Syrian wheat production. Actually, this is the essence of some futures studies methods.

6.2 List of all the variables/factors

From the previous steps, a list of **40** variables / factor is extracted; describing the strengths, weaknesses, opportunities, and threats of Syrian wheat production. This list is shown partly in Fig. 7. This list is very important to identify MDI matrix, and to study the direct (influence, dependence) among these variables. Fig. 8 illustrates WRT-Delphi-Oriented-MICMAC matrix.

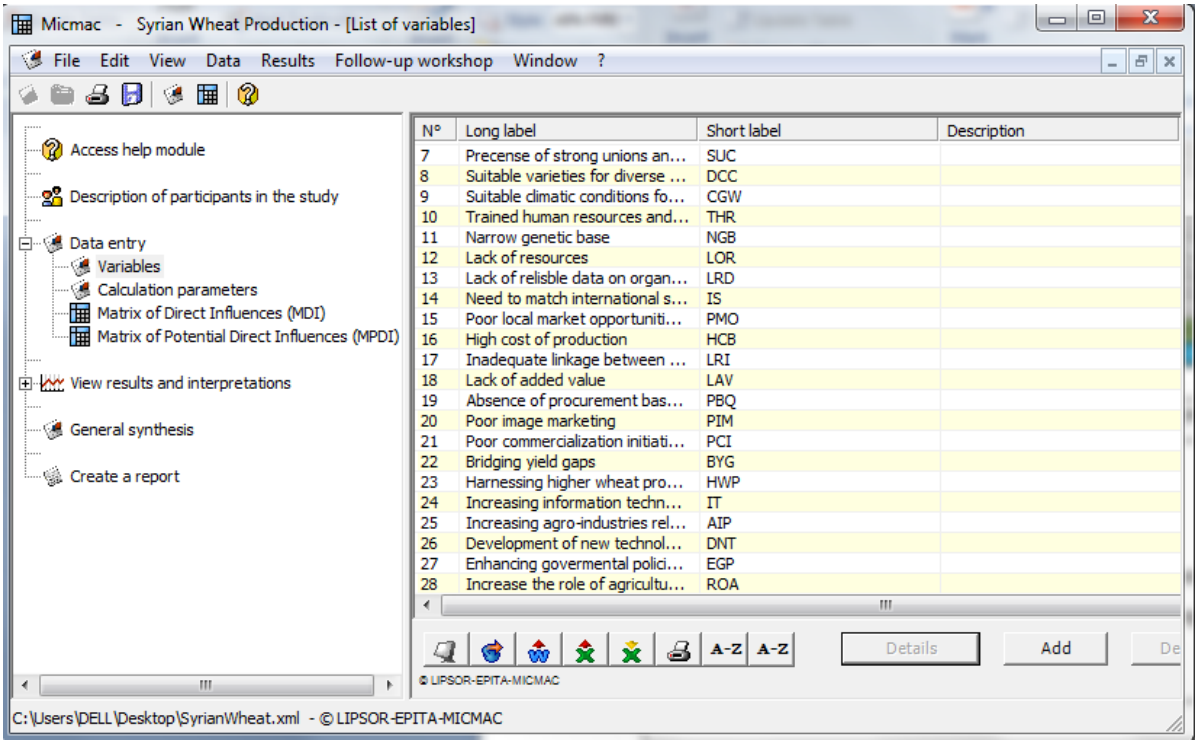
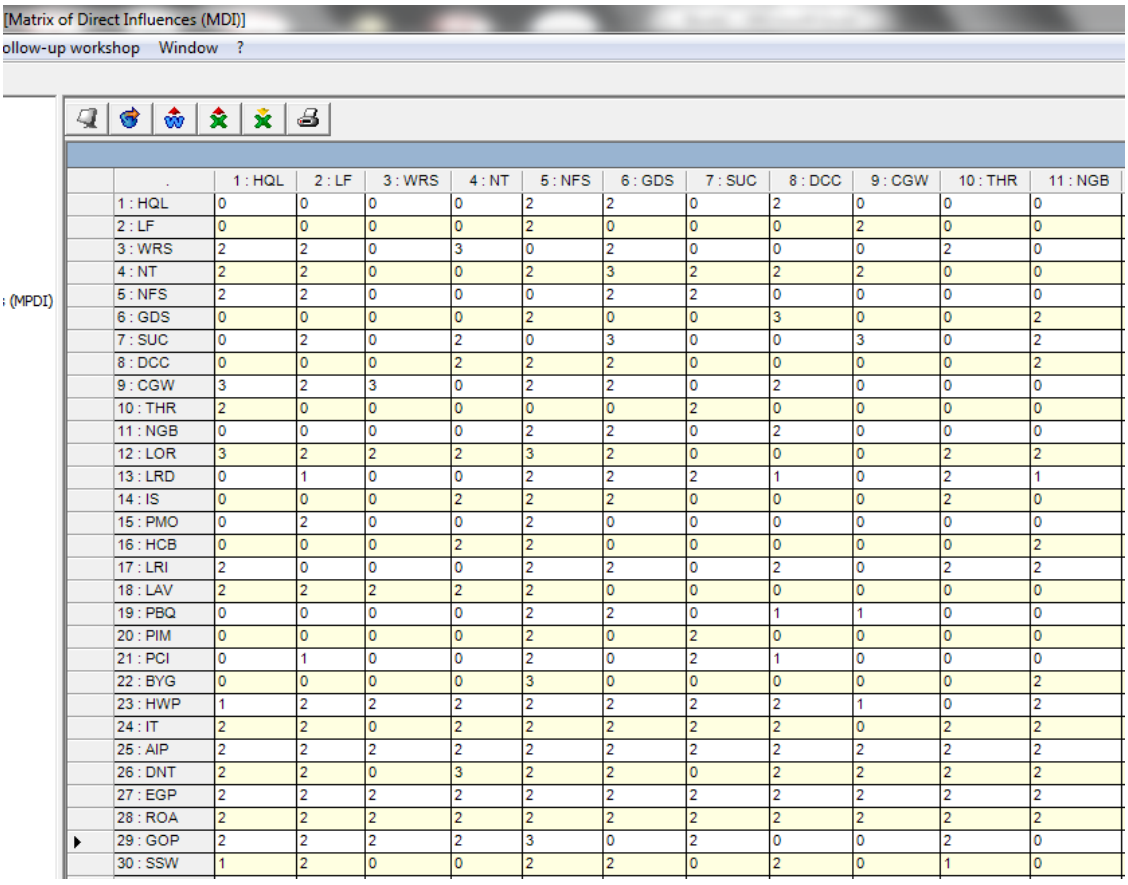


Fig. 7. Some variables/factors of Syrian wheat production



.	1 : HQL	2 : LF	3 : WRS	4 : NT	5 : NFS	6 : GDS	7 : SUC	8 : DCC	9 : CGW	10 : THR	11 : NGB
1 : HQL	0	0	0	0	2	2	0	2	0	0	0
2 : LF	0	0	0	0	2	0	0	0	2	0	0
3 : WRS	2	2	0	3	0	2	0	0	0	2	0
4 : NT	2	2	0	0	2	3	2	2	2	0	0
5 : NFS	2	2	0	0	0	2	2	0	0	0	0
6 : GDS	0	0	0	0	2	0	0	3	0	0	2
7 : SUC	0	2	0	2	0	3	0	0	3	0	2
8 : DCC	0	0	0	2	2	2	0	0	0	0	2
9 : CGW	3	2	3	0	2	2	0	2	0	0	0
10 : THR	2	0	0	0	0	0	2	0	0	0	0
11 : NGB	0	0	0	0	2	2	0	2	0	0	0
12 : LOR	3	2	2	2	3	2	0	0	0	2	2
13 : LRD	0	1	0	0	2	2	2	1	0	2	1
14 : IS	0	0	0	2	2	2	0	0	0	2	0
15 : PMO	0	2	0	0	2	0	0	0	0	0	0
16 : HCB	0	0	0	2	2	0	0	0	0	0	2
17 : LRI	2	0	0	0	2	2	0	2	0	2	2
18 : LAV	2	2	2	2	2	0	0	0	0	0	0
19 : PBQ	0	0	0	0	2	2	0	1	1	0	0
20 : PIM	0	0	0	0	2	0	2	0	0	0	0
21 : PCI	0	1	0	0	2	0	2	1	0	0	0
22 : BYG	0	0	0	0	3	0	0	0	0	0	2
23 : HWP	1	2	2	2	2	2	2	2	1	0	2
24 : IT	2	2	0	2	2	2	2	2	0	2	2
25 : AIP	2	2	2	2	2	2	2	2	2	2	2
26 : DNT	2	2	0	3	2	2	0	2	2	2	2
27 : EGP	2	2	2	2	2	2	2	2	2	2	2
28 : ROA	2	2	2	2	2	2	2	2	2	2	2
29 : GOP	2	2	2	2	3	0	2	0	0	2	0
30 : SSW	1	2	0	0	2	2	0	2	0	1	0

Fig. 8. MDI matrix of Syrian wheat production

The total of the connections in a row indicates the importance of the influence of a variable on the whole system. The total in a column indicates the degree of dependence of a variable (level of direct dependence).
Variables / factors in the influence / dependence chart could be visualized, this chart as shown in Fig. 9 is divided into four groups:

- ***Very influent and very dependent:*** This group contains these variables that are situated in the north-east frame of the chart which are by nature factors of instability since any action on them has consequences on the other variables. More of this could be found in [4].
- ***Very influent and little dependent:*** This group contains variables that are situated in the north-west frame of the chart. Most of the system thus depends on these variables. The influent variables are the most crucial elements since they can act on the system depending on how much can we control them as a key factor. They are also considered as input variables in the system.
- ***Little influent and very dependent:*** This group contains variables that are situated in the south-east frame of the chart. They are depending variables, or result variables.
- ***Little influent and little dependent:*** These variables are autonomous or excluded variables, which are situated in the south-west frame, and appear quite out of line with the system since they act neither to stop a major evolution undergone by the system, nor to really take advantage of it.

The graph of the direct influences among the variables shows the links correspond to the values of MDI matrix as shown in Fig. 10.

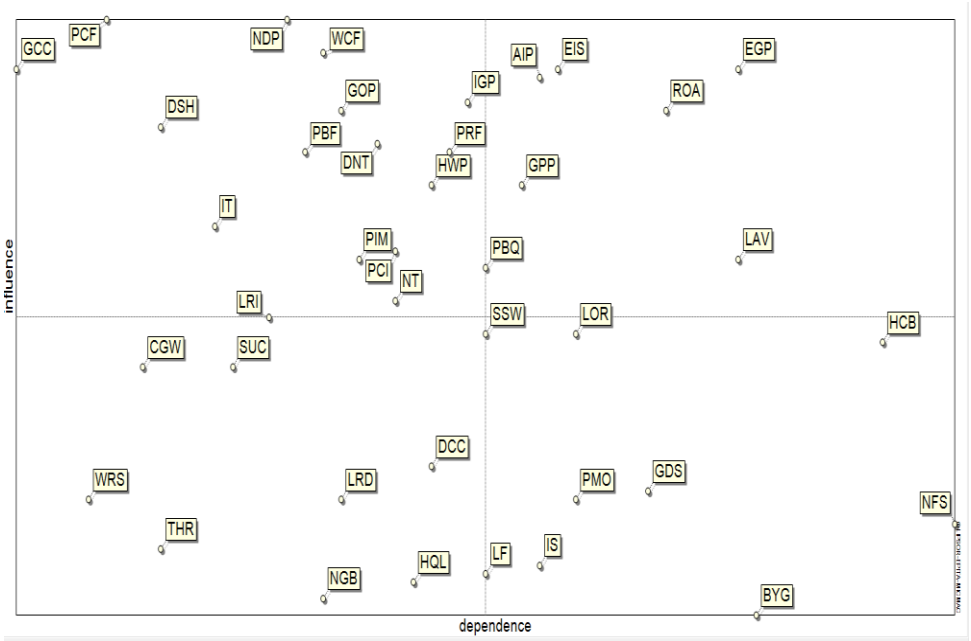


Fig. 9. The direct influence versus dependence chart

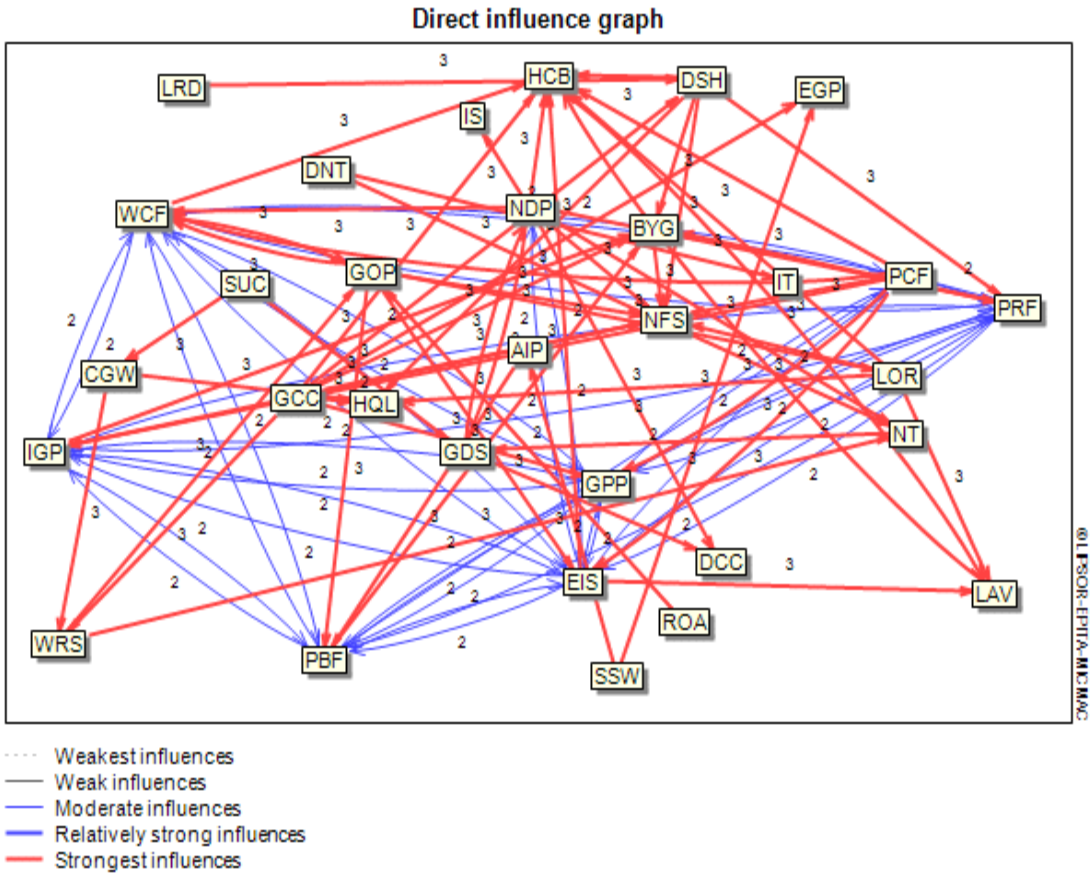


Fig. 10. The direct influence graph with 5%

This is not enough, the indirect relations among variables must be identified. The matrix of indirect influence MII is calculated by raising the MDI matrix to the power 5. The indirect influence versus dependence graph is shown in Fig. 11. below.

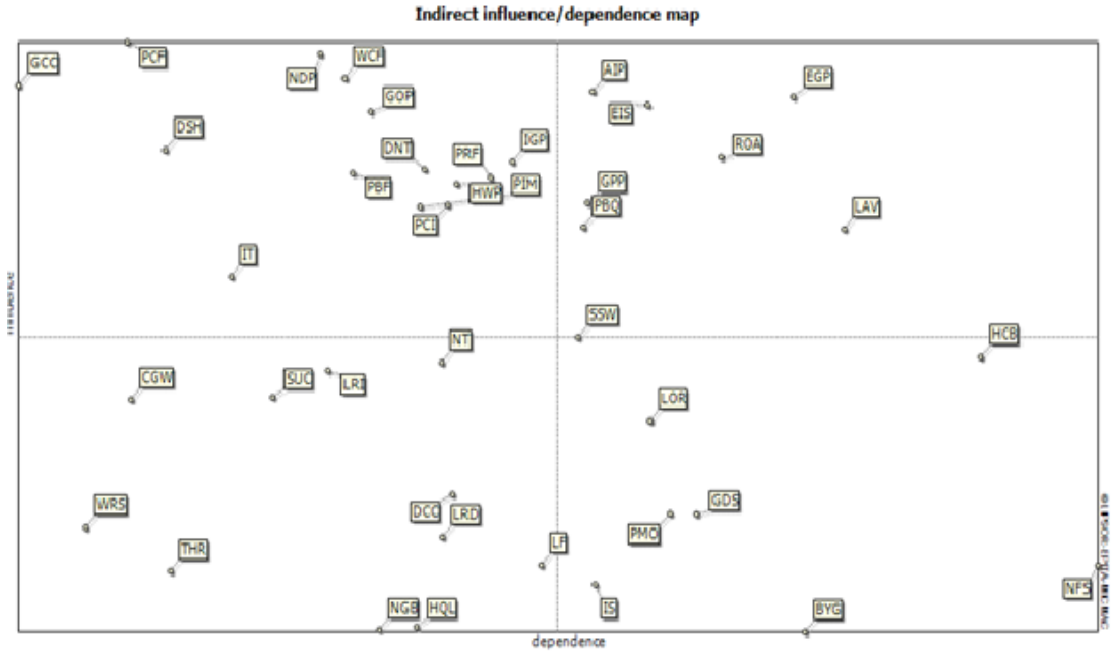


Fig. 11. Chart of the indirect influence versus dependence

The positions of variables stem from direct and indirect classifications of MICMAC method are compared and sorted with respect to their influence and are shown in Fig. 12.
This figure shows by direct classification using MDI matrix (variables on the left) that the first five variables (NCP, PCF, WCF, EGP, GCC) are more influential over other variables. But when the matrix MDI is raised to power 5 another classification (indirect) is produced and the order of variables are changed (variables on the right), and the order becomes as follow: PCF, NDP, WCF, and so on. This means that these variables now according to indirect classification are more influential than the others as shown in Fig. 12. In our case study the focus is on these variables, which are in fact the key variables.
On the other hand Fig. 13 shows the list of variables sorted by dependence. It can be noticed from the figure that NFS, HCB, LAV, BYG are more dependent on the other variables (variables on the right).
The graph of the indirect influences/dependence among the variables shows the links correspond to the values of MII matrix as shown in Fig. 14.

6.3 Identify the Key Variables and their Impacts

From the previous indirect classification as shown in Figs. 12, 13, the more influential variables are PCF, NDP, WCF and these variables represent the key variables of this study, where PCF: Political change variable, NDP: New diseases and insect pests, and WCF: Water scarcity factor. But some questions are raised: what are the magnitudes of impacts of these variables?, how do they affect each other?, what are the initial and conditional probabilities of these variables?

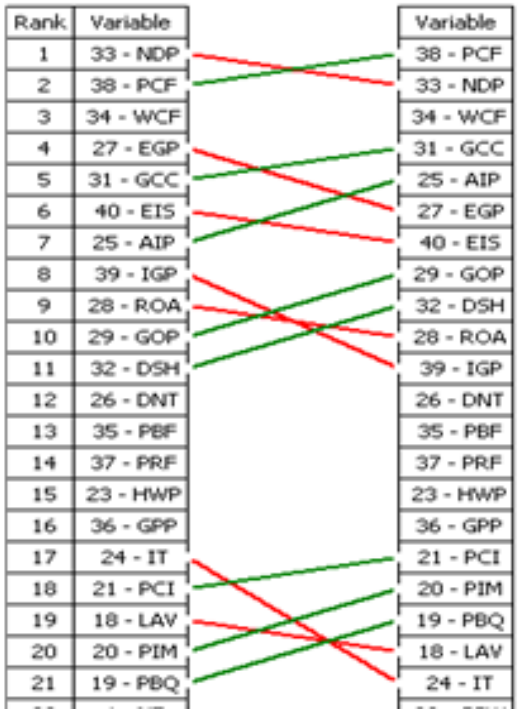


Fig. 12. List of some variables sorted by influence

Rank	Variable	Variable
1	5 - NFS	5 - NFS
2	16 - HCB	16 - HCB
3	22 - BYG	18 - LAV
4	18 - LAV	22 - BYG
5	27 - EGP	27 - EGP
6	28 - ROA	28 - ROA
7	6 - GDS	6 - GDS
8	12 - LOR	15 - PMO
9	15 - PMO	12 - LOR
10	40 - EIS	40 - EIS
11	14 - IS	14 - IS
12	25 - AIP	25 - AIP
13	36 - GPP	36 - GPP
14	2 - LF	19 - PBQ
15	19 - PBQ	30 - SSW
16	30 - SSW	2 - LF
17	39 - IGP	39 - IGP
18	37 - PRF	37 - PRF
19	8 - DCC	23 - HWP
20	23 - HWP	8 - DCC
21	1 - HQL	21 - PCI

Fig. 13. List of some variables sorted by dependence

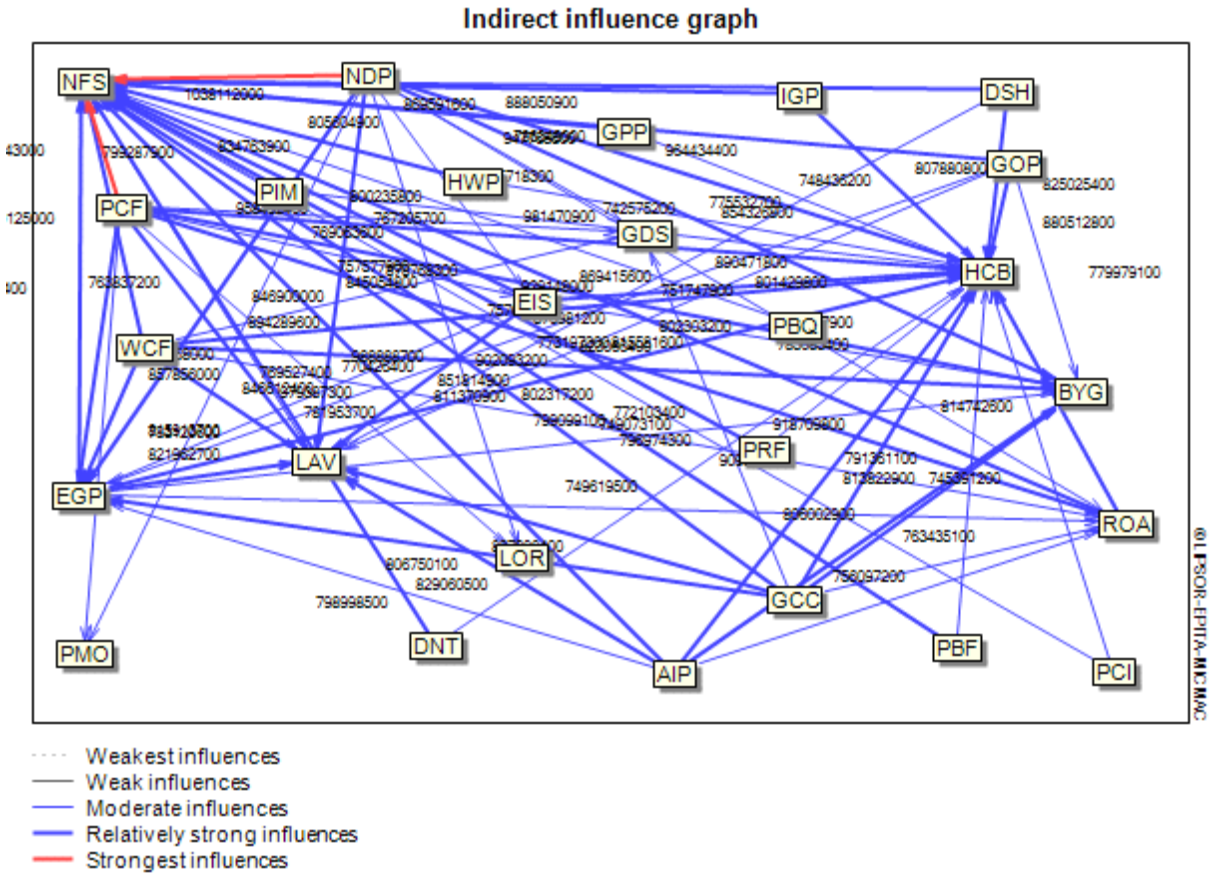


Fig. 14. Indirect influence graph with 5%

Studying the Impact of these Key Variables

6.4.1 Cross Impact Analysis

To answer the previous questions Chao's new look at cross-impact analysis method is used [7]. This method combined the level of anticipated future impact and their probability of occurrence, so that both were factors in the analysis. The combined results achieved served as basis for evaluating the future development.

In this study the new cross-impact analysis method is integrated with WRT-Delphi and hence the conditional probabilities of the first three key variables and their impacts are extracted by WRT-Delphi oriented CIA matrix. Let A be a *3* x *3* cross impact matrix with *3* possible events or trends. The entries *Aij* ($1 \leq i \leq 3$; $1 \leq j \leq 3$) are defined as shown in the Fig. 15.

Matrix A

	PCF	NDP	WSF
PCF	-3	-4	-5
NDP	-4	-2	-3
WSF	-4	-4	-3

Fig. 15. Cross impact matrix

In this matrix the driving events are the column events, and the driven events are the row events. That is, the matrix represents "if the column events were to occur, what is the magnitude of the impact to the row events?"

As shown in the matrix the three events have negative impacts on Wheat production as evidenced by their names.

Now a matrix *B* is defined, in Fig. 16, similar to *A*. Matrix *B* now represents "if the column events were to occur, what is the conditional probability of impact of the row events?"

Matrix B

	PCF	NDP	WSF
PCF	1	0.8	0.5
NDP	0.7	1	0.4
WSF	0.6	0.5	1

Fig. 16. Conditional probability matrix

Next an initial probability vector is constructed as a 3 dimensional vector**.**

$$\mathbf{P} = \begin{bmatrix} 0.7 \\ 0.5 \\ 0.4 \end{bmatrix}$$

where P_i is the initial probability of occurrence of event *i* for *i* = 1, 2, 3.

By creating a new matrix $X = [\ xij\ ]$ where $x_{ij} = a_{ij}\ b_{ij}$, which represents the likely impact of event *i* given the occurrence of event *j* as shown in Fig. 17. This matrix can serve as a basis for evaluating the risk in comparison to alternatives.

$$X = \begin{bmatrix} -3 & -3.2 & -2.5 \\ -2.8 & -2 & -1.2 \\ -2.4 & -2 & -3 \end{bmatrix}$$

Fig. 17. Likely impact matrix

Next a matrix multiplication is performed *XP*. Let *S* = *XP*, where *S* is a vector representing the expected impact of each event and is illustrated in Fig. 18.

$$Smax = XP = \begin{bmatrix} -4.7 \\ -3.44 \\ -3.88 \end{bmatrix}$$

Fig. 18. Expected Impact Vector

The vector *S* shows that the expected impact of the PCF, NDP and WSF to the Syrian wheat production is -4.7, -3.44 and -3.88 respectively. In fact this result can serve as a basis for evaluation of future development, and is a corner stone for further analysis to show how do these key variables affect the future of Syrian wheat production?, and how to benefit from these results in our advanced analysis.

7. Conclusions

The purpose of this paper is to explore strategic planning tools as essential frameworks to scan the environment of the system under study. These tools are integrated with some of futures studies methods e.g. WRT-Delphi, to direct these tools to be experts-oriented and to enhance the participation idea which can help in reducing uncertainties.

WRT-Delphi oriented strategic planning tools introduced in this paper are very important to study the environment and to analyze it internally and externally. This advanced analysis is performed using MICMAC method which in turn is oriented by WRT-Delphi to be WRT-Delphi oriented MICMAC method. Thus, a list of n variables is analyzed to extract the key variables. Furthermore, WRT-Delphi-Oriented-CIA method is used to study the impacts of these variables in addition to their initial and conditional probabilities.

WRT-Delphi oriented CIA method will result in a vector, which represents the expected impact of each event. Moreover, this method is further used in future work to extract the vector of the maximum impact of these events, and the vector of the steady state impacts, and these two vectors will be used in further analysis using Trend Impact Analysis method to show how these events could affect the future images of Syrian wheat production.

SPACE matrix is a good strategic planning tool that determines the type of strategy that should be pursued by the government. The results extracted from this tool were directed towards defensive strategy. Moreover, the Cross Impact Matrix shows negative impacts for the three key factors. This in turn indicates that the government should follow a defensive strategy. But this is not enough, further analysis using Trend Impact Analysis could show how these key factors could cause deviation of original surprise-free forecast if they were to occur, and what are the scenarios of Syrian Wheat production future.

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