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APPLICATION OF PROSPECTIVE STRUCTURAL ANALYSIS FOR IDENTIFICATION OF STRATEGIC VARIABLES IN THE FUTURE DEVELOPMENT OF BANEH CITY IN IRAN

1. INTRODUCTION

The increasing complexity and uncertainties of future developments in cities as well as the extended range of key factors from local to global levels make necessary adopting a new approach in urban planning. Futures research methods are increasingly applied in long term city planning. Baneh as an important city of Iran in Kurdistan province near the Iraq border has a special location and plays a key role in trade and business. The alternative futures of the city are shaped by a diverse set of variables from local to international levels and hence planning for the future is a challenge. In this research structural analysis is applied to assess the interrelationships of the underlying factors with respect to the long term developments of Baneh.

Futures studies is a knowledge area that opens eyes to events and the likely opportunities and threats. It alleviates ambiguities, doubts and concerns, enables the society to make smart choices, and makes clear where we can go (explorative futures) and where we should go (normative futures) and what could be shortcuts to desired futures. In short, futures studies should be regarded as an endeavor towards shaping the future in a conscious and proactive manner (Malekifar, 2009; Alizadeh *et al*., 2008). Futures studies means taking necessary actions for 1) interpreting the past; 2) understanding the present; 3) making decisions and

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taking action at present; and 4) balancing present and future use of resources (Bell, 2003). The most important objectives of futures studies that are endorsed by most professional futurists are identification, assessment, test, and suggestion of possible, probable, and preferable futures. Today a growing number of organizations engage in futures studies and encourage the institutionalization of this field of profession. That is because futures studies potentially contribute to building some inspiring visions and uncover ways to implement them.

2. URBAN PLANNING AND SYSTEM DYNAMICS

Urban planning is a recognized academic discipline which has evolved throughout history. Both its theory and practice have changed to fit developments in cities and urban characteristics, urban economy, and city environment to the extent that it now incorporates a rich base of approaches, models, and methods which correspond to specific circumstances and problems. From the middle of the 20th century, strategic planning and systems thinking were integrated in the scientific models of urban planning in order to better encounter some rapid and radical changes in built environments and emerging urban challenges. Futures studies could be regarded an evolution of strategic planning and system thinking that builds upon theoretical base of other similar disciplines and tries to address the increasingly complex environments and their related planning and management issues. Roney (2010), for instance, demonstrates that strategic planners and futures methodologists, in a complementary fashion, 'comprise communities of "engineers" who apply theory from the social and physical sciences in order to develop methods that aid management in making anticipatory decisions regarding resources deployment'. Futures studies and research entered the regional and urban planning in the last decades of the 20th century. In Europe, and in particular in Sweden, futures studies were widely accepted and applied in urban planning. Khakee is among the first scholars who applied futures research widely in spatial and urban planning. He incorporated futures thinking in several cities in Sweden and developed also a number of models to integrate the futures approach in city planning. Academic research in recent years shows an increasing trend in terms of publications that combine futures studies and urban planning (Khakee, 1993, 2010).

Moreover, Ratcliffe and Krawczyk (2011) are two other futurist experts who have done a great deal of research focused on the futures research in an urban planning framework. Krawczyk's (2006) PhD dissertation addresses future thinking in city planning processes with Dublin as the case study. She demonstrates the use of futures methods and models throughout the different steps of city planning system. Today a new generation of city models are 'viewing such

systems as being continually out-of-equilibrium with a dynamic driven from the bottom up' (Batty and Marshall, 2012).

In Iran the application of futures research, and in particular *scenario planning*, is emerging (Motlagh, 2013). However, if we consider strategic planning as the historical background one can compile a list of application of strategic planning concepts and methods in city planning. City Development Strategies (CDS) are urban plans that apply strategic planning concepts and aim to provide long term visions for cities. Such plans have been developed for several major cities across the country and eventually implemented. Nader Zali (2010) has produced a PhD dissertation. He discusses future developments based on 'national perspective and province development foundational theory by using strategic management approaches relying on scenario- based planning models'. Moreover, he uses scenario wizard software in regional planning. In addition, researchers from AtiNegaar Think Tank have done a commercial in-depth research project of spatial planning based on foresight and scenario planning methods for Hamedan Province in Iran.

3. STRUCTURAL ANALYSIS

Prospective structural analysis, as a common futures research method, has been developed and widely applied by French scholars. System approaches emerged from the pioneering works of Forrester in industrial and urban dynamics in the 1960s. Such research projects provided enough justification for structural analysis. The reports by Club of Rome, and in particular *Limits to Growth*, drew wide public attention to system dynamics, even though the conclusions of such models are still fiercely debated among professional futurists. In order to address the whole system and make sense of the evolution of multiple and homogenous quantitative and qualitative variables, the structural analysis employs *matrix and chart as tools of representation and visualization*. This particular method of system dynamics has been applied to diverse case studies from water to transportation to energy systems. Structural analysis has been used to uncover the factors which guide nuclear energy sector in France (Arcade *et al*., 2009). Iranian futurist scholars have also widely applied structural analysis to develop multiple scenarios for the national science and technology roadmap (Motlagh, 2013).

The method of structural analysis aims to identify the key factors in the global dynamics so as to receive insights from participants and to encourage reflection in the group on the complex and unpredictable long term evolution of a system. It sheds light on the configuration of the system under study and 'linkup ideas'. The major advantage of this method is finding the web of interrelations among variables and eventually surfacing the key factors. It could be used, qualitatively, to study diverse systems.

Futures Research Methodology, published by the Millennium Project, provides a manual on the history, step by step procedure, and case studies of structural analysis applications (Arcade *et al*., 2009). Structural analysis follows a step by step procedure as described below.

Step One: Collecting the list or inventory of variables.

Step Two: Establishing the web of interrelations.

Step Three: Identifying key factors.

In the first step, based on interview with experts and brainstorming sessions, an inventory of variables is produced which is ideally exhaustive and descriptive of the whole system covering both internal and external aspects. After setting the elements of the system the task in step two is to bring to light the web of interrelations in terms of influence or dependence among those elements. It is recommended to group the elements or variables into distinct categories and provide a homogenous list. A common grouping suggests splitting variables into a) internal system; b) specific context; and c) global environment. Structural analysis put the variables in rows and columns of a matrix and then they were crossed to assign influence scores ranged from 3 (strong) to 1 (weak) to indicate the intensity of influence that the variable *i* has on the variable *j*. If, based on qualitative perceptions, there is no influence between pairs of variables the corresponding element in the matrix remains empty and if a potential influence is deemed appropriate the letter *P* is inserted (see figure 1). At this stage only direct influence is determined and recorded. The think group is recommended to focus on the most direct and not intermediary relations in this stage. If the influence of variable *i* on *j* goes via *k* the researcher should put the score of influence from *k* to *j*. This step in itself helps to redefine the system, revise the list of variables, revise the grouping and establish a common language for better collaboration among researchers. Filling rate of matrix is often nearly 20% yet the internal system block of variables has a higher rate than average. All variables in the systems are visualized in an influence *x* dependence plane. Adding up the scores for each row and column indicates how much influence or dependence each variable has in the whole system. Step 3 addresses the feedback and loops which are essential notions in system dynamics. A direct influence from a variable onto another could be weak yet it might be the case that its global influence may increase tenfold through particularly strong variables. Therefore structural analysis also takes into account the indirect propagation of the variables' influence in the web of interrelations. It can be shown that if we raise the structural matrix to the power of successive values from 2 up to n then we obtain a new matrix in which each element in the matrix incorporates both direct as well as indirect (feedback and loops) relations among variables. Human mental capacity is limited to address this step of structural analysis and hence a software called MICMAC is used. The ranking of variables generally becomes stable in less than 9 multiplications of the original matrix (Godet, 2006).

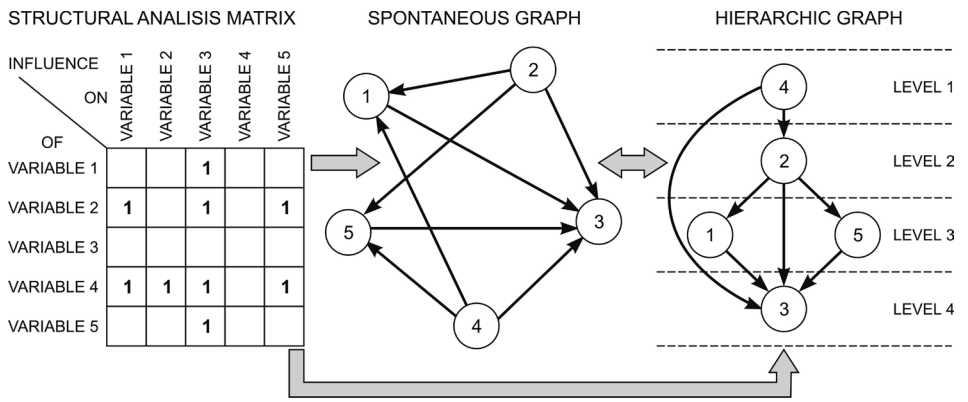

Fig. 1. The structural analysis matrix and its graphs
Source: Arcade (2000). Used with permission

4. DATA AND RESULTS

Baneh is a small city in Iran with a population of nearly 85,000 which is located on Iran-Iraq border. Despite its small size, this city is remarkable among Iranians because of the inexpensive luxury products that are sold in its markets and shopping centres. In recent years it has turned into a hub for trading and importing goods to Iran from countries such as China, Taiwan, Indonesia, Turkey, and some European countries. Traders purchase relatively cheap goods and import them to Iran via Iraq border. Trading business has made a huge impact on the city and has boosted the pace of its development. This big change has resulted in transforming many residential and public premises into retail shops and business offices. Moreover, a palpable change can be seen in the economic and social aspects of life in the city. The rapid rate of change brings to light a multifaceted puzzle and a number of questions:

1. Given the large scale changes in city developments what could unfold in the long-term future of Baneh?
2. What could be the variables that play some role in the future development of this city?
3. Which variables are more strategic and could be subject to either monitoring or manipulation?

Our study tries to address these questions. Findings provide a preliminary set of insights that help us make better sense of potential answers.

The inventory of variables was elicited through a step by step process. In the first step environmental scanning was used to identify the most important issues with

respect to the city that were already mentioned in oral and written sources. Variables such as incoming businesspersons and other related tourists; incoming *smuggled* cheap products that often are not manufactured inside Iran; and the growth of investment in the city were among the most significant problems and issues surfaced in this step.

In the second step, the resources in the city development literature were studied. A crucial insight was that in urban planning and city geography, all the relevant variables are grouped based on different categorization logic. In one of the common approaches, factors are categorized in different spatial levels which usually include local, national, and global levels. Yet in other approaches variables are grouped into different topics such as economic, natural, and cultural factors. However, taking into account the border geography of Baneh which implies that the city development will be shaped by incoming, often smuggled, goods from abroad, the spatial approach was used to include all relevant factors from local to international levels. Next a questionnaire was designed and distributed among a pool of experts, asking them to both validate the listed factors and make suggestions on all spatial levels. The pool of experts was composed of people with significant involvement in both the practice and theory of city development, such as: Baneh municipality managers and professionals (5 persons); Baneh city council members (5 persons); Baneh governor office professionals (5 persons); professional graduates of related academic disciplines such as management, economics, social sciences, and political science (20 persons); and professional graduates of geography and urban planning (15 persons).

The questionnaire was sent to the respondents both in print and online version. For the online version Google Docs free service was used. The online questionnaire was also promoted on a website specifically designed for and updated on futures studies and urban planning: http://www.futureplan.ir. The online questionnaire was also sent to more than 100 experts who were members in social networks such as Facebook (popular yet censored in Iran, people use anti-filter applications to log in), Cloob.com (popular and government approved), and IrExpert.ir (popular and government approved). The number of responses to online questionnaire from social network members was quite low with only 5 persons filling it out.

In the third step and after receiving no more suggestions and feedback on the inventory of relevant variables, the screening process began. As a result 54 variables from local, national, regional, and international levels affecting the city development of Baneh were listed.

In the fourth step a select group of 5 experts and city professionals adjusted the list to 52 items and judged the crossing scores of variables in two half-day workshops. After the numerical elements of the matrix were determined it was then used as the input to the MICMAC software and the results were analyzed. The list of 52 variables grouped in four categories at international, regional, national, and provincial levels and abbreviations used in the MICMAC software are shown in tables 1 and 3.

Table 1. 52 variables grouped in four categories at international, regional, national, and local levels

International	economic sanctions, improvement of foreign relations, economic and political ties between Iran and East Asian countries, US dollar exchange rate fluctuations, gold and oil prices fluctuations, satellite TV channels, global security, improvement of global transportation system, natural future of the world
Regional	stability of Arab governments, Middle East security, stability of Iraq government, improvement of Iraqi transportation network, Iraqi Kurdistan security, Iran-Iraq relations, Iran-Iraqi Kurdistan relations, improvement of trade relations between Iran and its region, cultural- ethnic- linguistic ties between people on border sides of Iran-Iraq and Iran-Turkey, development of regional transportation companies, investment by large regional corporations
National	development of suitable customs, laws and regulations, building infrastructures and improving customs management system, national planning for management of border local markets, national TV and media and news coverage of the city, political approach of government to areas populated by the Kurd ethnic group, earmarked budget for border areas, national product, national aggregate demand, improvement of national transportation network, national security, borders security, political stability of Iran, importance of tourism industry in national development policy, spatial planning
Local	building tourism infrastructure, city perspective and fabric, city and provincial transportation, local media, city management system, people training courses for good treatment of tourists, facilitation of investment, natural potentials of the area, building factories and industries in the area, city and provincial management, relative situation of Baneh city, development of Baneh, job creation, supervising the budget spending, promotion of natural tourist attractions, amount of goods flowing to the city, number of incoming tourists to the city, quality control of input goods

Source: authors' elaboration.

5. INTERPRETATION OF THE INFLUENCE X DEPENDENCE CHART AND TYPOLOGY OF VARIABLES

Visualization of the web or graph of interrelations (see figure 4) could be done in a chart in which horizontal and vertical axes are scaled to increasing intensity of respectively dependence and influence of factors based on their total scores. The cloud of points as shown in figures 2 and 3 can be divided into distinct categories with different roles in the system's global dynamics.

Determinant factors (located in north-west part). These are very influent factors. Depending on how much we can control them this set of variables determines inertia or movement of the system. Often environment variables are among them since they strongly condition the system. For the case of Baneh city determinant factors are: natural future of the world, political stability of Iran, national security, borders security, political approach of government to areas populated by the Kurd ethnic group, national planning for management of border local markets, Iran-Iraq relations, national aggregate demand, development of suitable customs laws and regulations, city and provincial management.

Relay factors (located in north-east part). These are both very influent and very dependent. Also called factors of instability because have a 'boomerang effect' and can either amplify or forestall any initial impulse in the system. Only a few, precisely 3, variables are seen in this part of the plane. Moreover*, earmarked budget for border areas* as a variable is located between relay and depending parts of the chart and it might be the case that if we produce the indirect plus direct matrix in the next step of structural analysis it will move to the part of relay variables.

Excluded (located in south-west part). These are variables with little influence and little dependence. Apparently they are 'out of line' with the system because can neither stop a major evolution nor take advantage of it. However, a distinction could be made within this group of factors. Disconnected variables are located near the origin of axes and we can remove them from the global dynamics and secondary levers, above the diagonal, with a degree of influence, they could be used as possible accompanying measures. For the case of Baneh city the cloud of points in this part of the chart are distributed almost uniformly. It is worthwhile to note that *city management system* lies here and therefore is an excluded factor from the whole system. This may be due to the fact that the future of the city will be shaped by some higher level variables that are effectively controlled by the central government. Nonetheless, it is a secondary lever and is rather influent than dependent. The list of disconnected variables that could be safely discarded consists of: satellite TV channels, improvement of global transportation system, promotion of natural tourist attractions, people training courses for good treatment of tourists, supervising the budget spending, improvement of Iraqi transportation network, US dollar exchange rate fluctuations, and local media.

Depending (located in south-east part). These are exit variables of the system, also called *result variables*. Their location on the plane indicates little influence and high dependence. Therefore, they are highly sensitive to the influencing factors. As expected most of them are related to the local level of the Baneh city and only a few factors from the international and national level factors belong to this part of the chart.

Another type of variables is also recognized in the influence *x* dependence plane which are located in 'the centre of gravity'. These are *regulating variables* and may

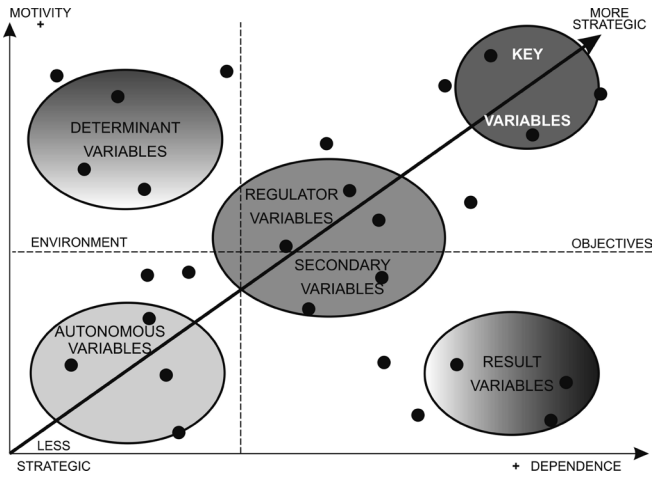

Fig. 2. Typology of variables in the influence x dependence plane
Source: Ambrosio Albalá *et al.* (2009). Used with permission

play alternatively the role of secondary levers, weak objectives, and secondary stakes. In the system of Baneh city only a few factors qualify to be regulating ones which are: Iran-Iraq relations, building infrastructures and improving customs management system, and development of regional transportation companies.

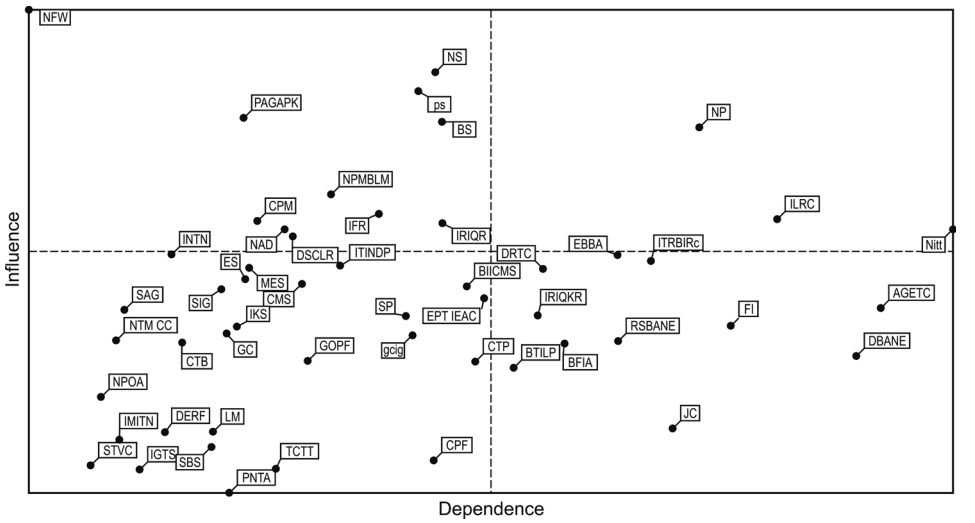

Fig. 3. Direct influence x dependence map
Source: authors' elaboration

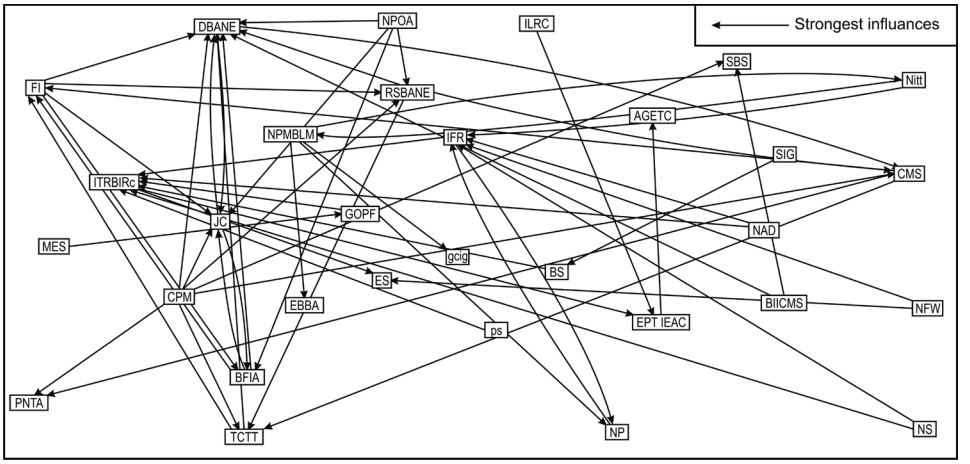

Fig. 4. Direct influence graph
Source: authors' elaboration

6. THE INDIRECT CLASSIFICATION

As noted above, to consider the propagation of loops and feedback among the variables the original matrix should be raised to successive powers. The set of scores in the original matrix was used as the input to the MICMAC software. The matrix, then, was raised to power of 4 and showed satisfying stability in terms of ranking of variables. The summary of variables raking based on the indirect classification is provided in figure 8. New total scores in rows and columns could imply significant change in the pattern of variables' distribution across the influence x dependence plane and influence graph as shown in figures 5–6. The summary of matrix characteristics is provided in table 2.

Table 2. Summary of matrix characteristics for indirect influences and dependences

Indicator	Value
Matrix size	52
Number of iterations	4
Number of zeros	1,570

Indicator	Value
Number of ones	345
Number of twos	376
Number of threes	413
Number of P	0
Total	1,134
Filling rate	41.93787%

Source: authors' elaboration.

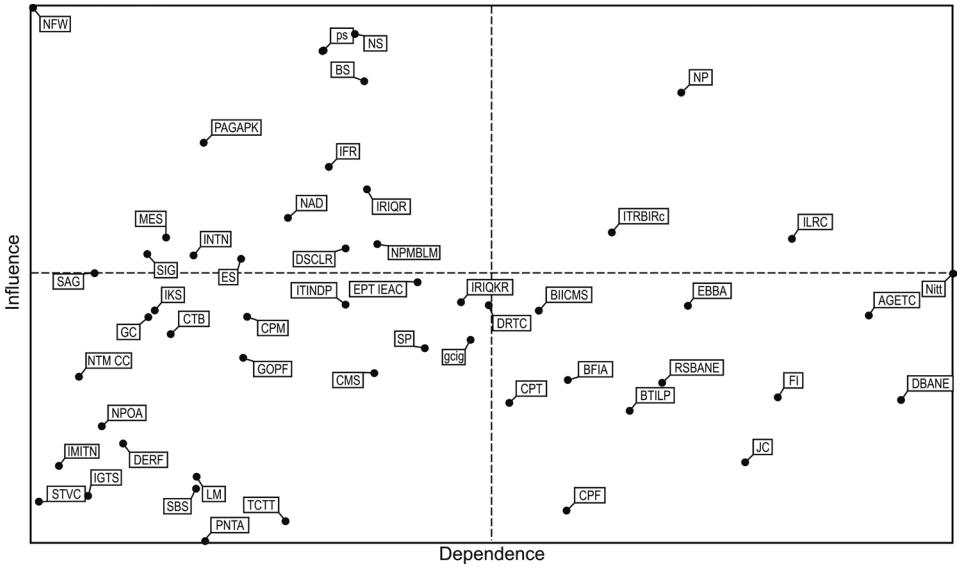

Fig. 5. Indirect influence x dependence map
Source: authors' elaboration

The output of the model for indirect classification points out that influent factors are turned even more influent. The same also applies to the dependent variables now located further away in the lower right part of the plane. This new pattern of points and the associated displacement with indirect classification only make the whole system more stable. Figure 7 shows the displacement map across all variables.

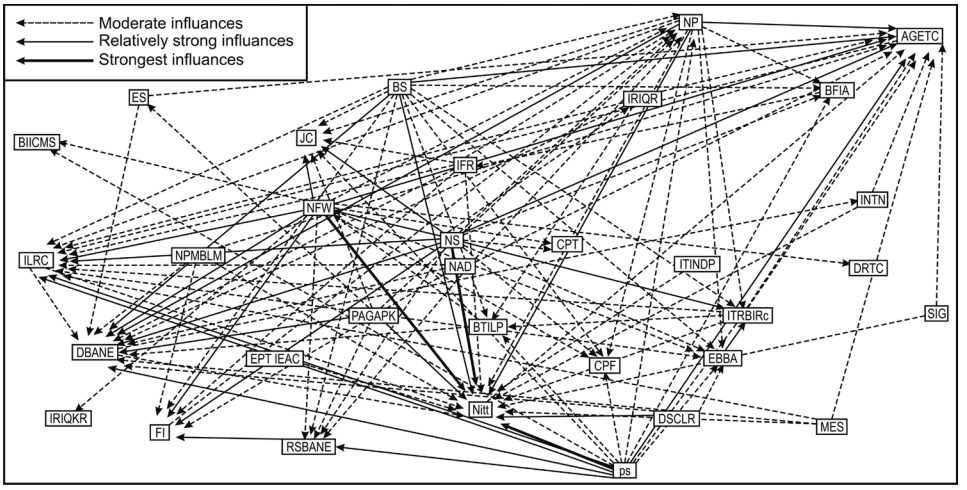

Fig. 6. Indirect influence graph
Source: authors' elaboration

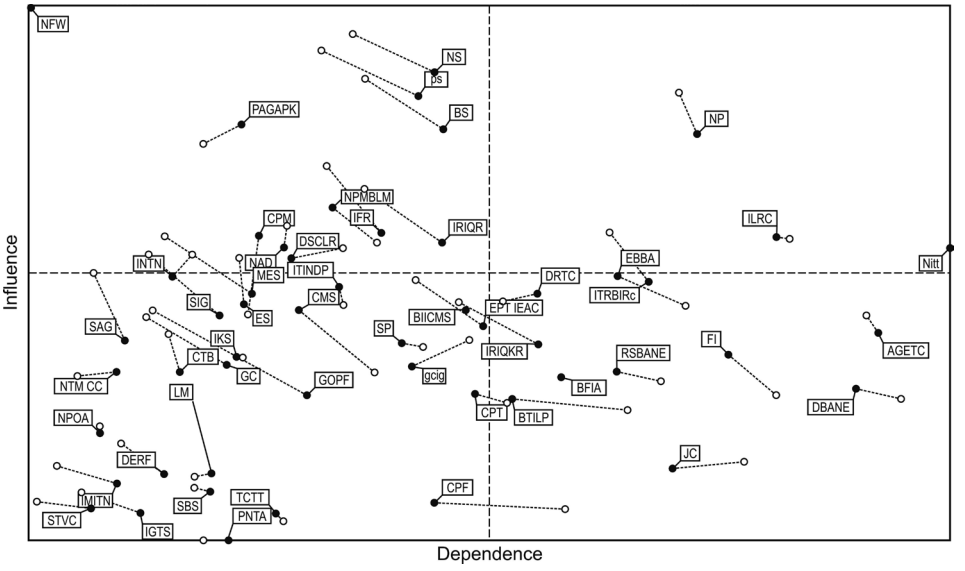

Fig. 7. Displacement map: direct/indirect
Source: authors' elaboration

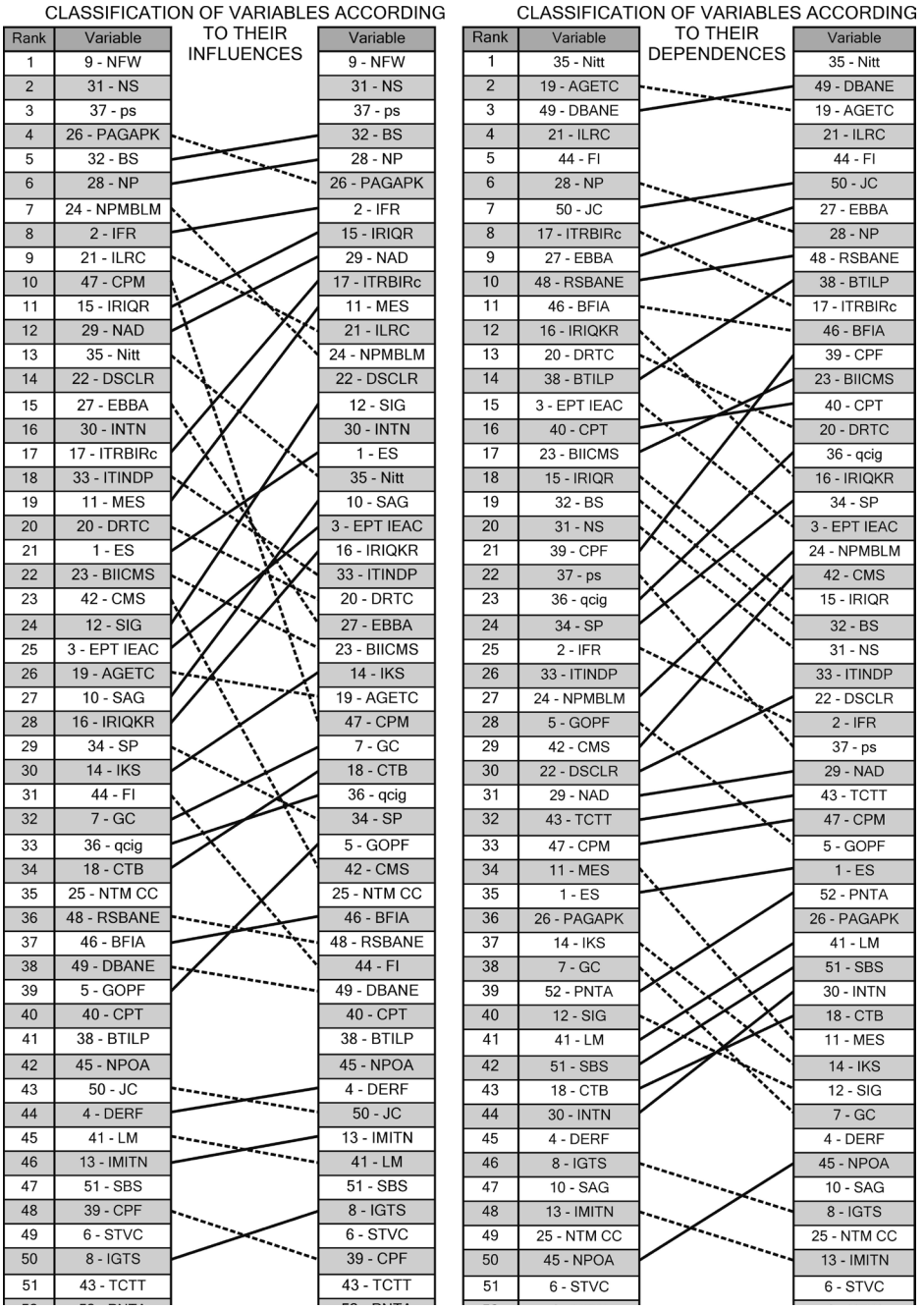

Fig. 8. Comparison of influencing and depending variables ranking based on the direct and indirect classifications

Source: authors' elaboration

7. STABILITY AND INSTABILITY

The general pattern of the positions of the variables on the plane helps us make sense of the general stability of the system. Clearly *an L shaped pattern* demonstrates a system with a number of influent and dependent variables, with few or limited number of excluded and relay variables, and therefore more stable. But a pattern of points in the upper right and lower left parts and around the diagonal only results in more instability of the global dynamics. In the case study of Baneh city the pattern of variables dispersion across the plane almost follows an L shape (see figure 9) and as a result the whole system is rather stable.

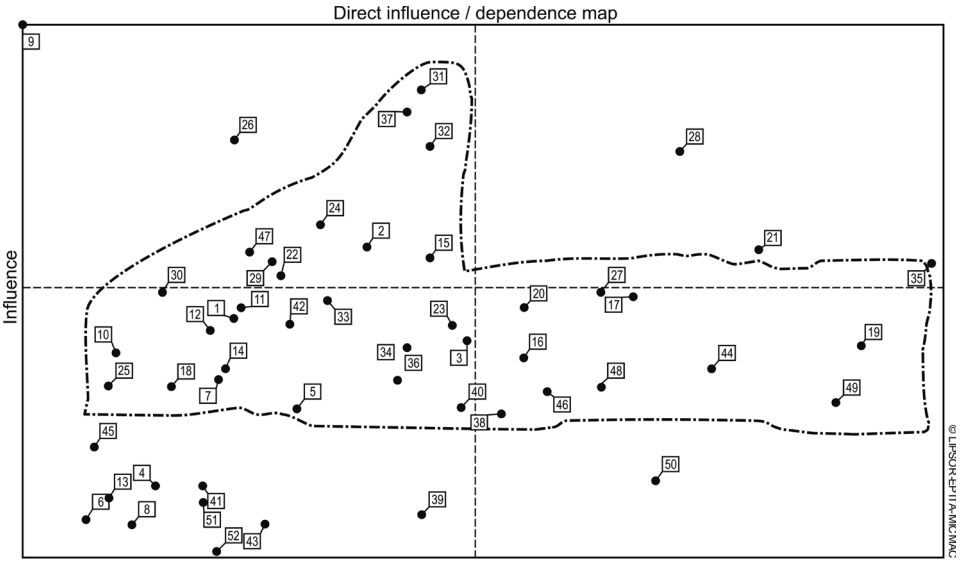

Fig. 9. L shaped pattern of variables dispersion
Source: authors' elaboration

8. KNOWLEDGE LIMITATIONS

Several difficulties hindered the quality of this research. Among them the most important are:

1. Most of experts were not familiar with prospective structural analysis in general and with futures studies/research in particular.

2. Most of experts required significant training on how to work with the MICMAC software.

3. Most of professionals responsible for city affairs were not knowledgeable enough about the whole system development of a city in its wider environment, important processes in the built-environment, and all variables that are affecting a city development.

4. This extended and complex topic of study requires interdisciplinary knowledge and understanding which is quite rare among the city officials and professionals.

Despite these challenges that undermine the credibly of results reported and analyzed here we have to note that *trial and error in applying futures research* methods can educate both experts and laypersons in system dynamics and futures studies in order to engage them in more long-term informed discussions with respect to the alternative futures of the city development.

Like other methods that rely on the opinion and judgment of experts and citizens, the prospective structural analysis of the interrelationships among different variables too faces the challenge of incomplete understanding and perception of experts when dealing with a complex topic. Clearly the knowledge of experts and professionals is reliable and credible to a limited extend. In addition to this problem, the complexity and the interdisciplinary nature of the city development on the one hand, and the relative small size of the city on the other hand significantly reduce the size of pool of experts and qualified researchers. Also, the remarkably low participation rate of online experts in social networks and the constraints to online engagement of citizens in serious minded research efforts could be some worthwhile ideas for further investigations.

Overall our findings suggest that the application of prospective structural analysis is helpful to uncover the dynamics of factors and provide a set of system based insights which could ways to shape the alternative futures of a small yet important city in Iran. In particular, in the absence of reliable quantitative databases of important statistics, a common challenge for researchers in countries like Iran, structural analysis is an important tool to make sense of any environment and to identify factors that could affect the alternative futures of systems. In other words, faced with the challenge of lack of data, incomplete data, and lack of important statistical indexes in order to monitor the trends, the researchers could use structural analysis as a suitable tool to gain some important insights so as to provide a list of recommendations.

9. CONCLUSIONS

Using environmental scanning and trend analysis techniques an inventory of variables was identified. Then 52 variables from different spatial levels (international, regional, national, and local) were selected as the most important

variables for prospective structural analysis. Structural analysis helps explore the structure and dynamics of a system as well as its web of interrelations. The results here show a rather dispersed set of variables across the influence x dependence plane. Based on the visualization it is evident that the number of variables with moderate degrees of influence and dependence is large and thus *the system is stable*.

Structural analysis is a method of futures that sheds light on the global dynamics of systems and help building a web of complex interrelations among diverse variables. Also the stake factors which are those variables that exhibit both high influence and high dependence not only could provide a boomerang effect but also hint to potential breakpoint of the system. These are *1) national product; 2) amount of goods entering the city; 3) number of incoming tourists to the city; 4) city and provincial transportation; and 5) facilitation of investment*. Hence, emphasis on monitoring these variables and directing the managerial effort toward guiding them in the path of desired evolution of the system is highly recommended. The relative shortage of such variables is one of the problems that the Baneh system of urban planning will have to face in the future.

Table 3. List of 52 variables and abbreviations used in the MICMAC software

Economic sanctions	ES
Improvement of foreign relations	IFR
Economic and political ties between Iran and East Asia countries	EPT IEAC
US Dollar exchange rate fluctuations	DERF
Gold and Oil prices fluctuations	GOPF
Satellite TV channels	STVC
Global security	GC
Improvement of global transportation system	IGTS
Natural Future of World	NFW
Stability of Arab governments	SAG
Middle East security	MES
Stability of Iraq government	SIG
Improvement of Iraqi transportation network	IMITN
Iraqi Kurdistan security	IKS

Iran-Iraq relations	IRIQR
Iran-Iraqi Kurdistan relations	IRIQKR
Improvement of trade relations between Iran and region countries	ITRBIRc
Cultural ties between people on borders side	CTB
Amount of goods entering the city	AGETC
Development of regional transportation companies	DRTC
Investment by large regional corporations	ILRC
Development of suitable customs laws and regulations	DSCLR
Building infrastructures and improving customs management system	BIICMS
National planning for management of border local markets	NPMBLM
National TV and media and news coverage of the city	NTM CC
Political approach of government to areas populated by the Kurd ethnic group	PAGAPK
Earmarked budget for border areas	EBBA
National product	NP
National aggregate demand	NAD
Improvement of national transportation network	INTN
National security	NS
Border security	BS
Importance of tourism industry in national development policy	ITINDP
Spatial planning	SP
Number of incoming tourists to the city	Nitt
Quality control of inputs goods	qcig
Political stability	ps
Building tourism infrastructure in local place	BTILP
City perspective and fabric	CPF
City and provincial transportation	CPT
Local media	LM
City management system	CMS

Table 3 (cont.)

People training courses for good treatment of tourists	TCTT
Facilitation of investment	FI
Natural potentials of the area	NPOA
Building factories and industries in the area	BFIA
City and provincial management	CPM
Relative situation of Baneh city	RSBANE
Development of Baneh	DBANE
Job creation	JC
Supervising the budget spending	SBS
Promotion of natural tourist attractions	PNTA

Source: authors' elaboration.

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