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Article *in* Foresight · April 2010

DOI: 10.1108/14636681011035771

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Scenario Planning for Climate Strategies Development by Integrating Group Delphi, AHP and Dynamic Fuzzy Cognitive Maps

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Abstract--A hybrid approach to scenario planning by integrating group Delphi method, AHP (Analytic Hierarchy Process) and dynamic fuzzy cognitive maps is proposed in the paper. The group Delphi method is employed to help group of experts to identify which worldwide forces have a major impact on climate related issues and how they interact together. In the second phase is assessed the value range that different variables of the proposed system can achieve and the impact that they have on each other. Assessment of the impact is done by use of the multiplicative AHP. During this phase the expert group also identifies which mathematical function (e.g. linear, sigmoid, concave, convex etc.) most properly describes relation between different forces. Based on this data a fuzzy cognitive map is developed as a base for a dynamic simulation of the world climate development. The simulation aims to serve as a source of guidelines about future organisational and technological changes, which can deliver a superior competitive position based on sustainable development strategy.

I. INTRODUCTION

The detection of key organisational areas and technologies which can have a positive impact on climate related issues is a constant challenge for academics, practitioners and policy makers. On the one side is a desire for exploitation of new market opportunities and achievement of the sustainable competitive advantage, on the other side the extenuation of pollution and negative industrial impacts on nature. Inappropriate behaving of industrial society and over exploitation of natural resources have brought evident unnatural climate changes that embrace global warming and the ozone hole.

In the following sections we want to present the common use of Delphi method, Analytic Hierarchy Process (AHP) and dynamic fuzzy cognitive maps for development of a future scenario as a learning device. The article in general presents and analyzes the application of referring methods within the scenario methodology in correlation with climate warming. Therefore it should not be understood as a complete problem solving framework for climate related issues. Such a framework would furthermore have to include a broader panel of experts from different scientific fields.

The application of different methods, which are based on expert judgements, has its advantages in comparison to methods, which are based on statistic analyzes of past data, as for example extrapolation and econometrics, regarding long term scenarios development. In the former experts can adjust their judgements on the basis of recent events, whose effects are not yet evident. The statistic methods are not capable of such adjustment and are therefore more appropriate for short term predictions [1].

The article is structured in four basic parts. In the second part the theoretical basis of the Delphi method, multiplicative AHP and dynamic fuzzy cognitive maps are presented. The third part describes the application of referring methods based on the example of the future scenario related to climate warming. Based on the performed simulation the fourth part offers some directions for organisational and technological change, which could foster organisational competitive advantage in the future. In the last part some findings from the application of referring methods are discussed.

II. THEORETICAL IMPLICATIONS

A. The Delphi Method

The Delphi Method has been for the first time presented in late sixties of the 20th century by Dalkey and Helmer from Rand Corporation for the purpose of technological development. Nowadays the method is used for environmental, technological, marketing and sale predictions. The method is treated as an instrument stimulating the credible debate that is independent of subjective individual power of those, who take part in it. There is an incontestable fact that in the group decision-making process certain social interactions emerge which are based on individual power (physical, professional, hierarchical etc.) and personal characteristics of the participants. The Delphi Method tries to reduce mentioned influences by establishing anonymous group communication with feedback. Anonymous means that no one within the group knows other members, who take part in the process as well. Normally highly structured questionnaires are used in the process. Different judgements and opinions of group members are summarized, combined and sent back to further judgement. Mentioned process reduces the impact of the most powerful members and avoids imposition of their points of view on other group members. In brief, the Delphi Method enables effective knowledge management of group as a whole in order to solve complex problems [8].

B. Analytic Hierarchy Process

Analytic Hierarchy Process (AHP) is a multi criteria decision method, which was developed by Thomas Saaty at the Wharton School of Business. It has been further supplemented by other researchers as well. Within AHP the decision problem needs to be hierarchically structured in relation to the main goal. Furthermore, we need to make pair comparisons at each level of the hierarchical structure composed of criteria in the way to assess the overall priorities of the alternatives in relation to the main goal. This can be done by use of the nine points referential scale and written in a form of a square matrix called preference or pairwise comparison matrix for which we calculate a largest eigenvalue [12]. In the nine points scale proposed originally by Saaty number »9« represent that the criteria *i* is extremely more important/relevant in respect to the criteria *j* regarding to the superordinate goal. The opposite is measured by the inverse (1/9).

The value selection for expressing preferences according to AHP method is not supported by all researchers. All the weaknesses from the original model have not yet been abolished, although Saaty in his work tried to prove the accuracy of his choice [12]. Therefore we will use the modified AHP method in our research, which is known as multiplicative AHP. The multiplicative AHP defines preferences as powers of number two. The whole procedure is based on calculating the geometric mean [9].

As decision makers can be inconsistent because of the intransitivity in their judgments the AHP method has tools for consistence analysis. The tool most used is the Consistence Ration (CR). The CR tests the consistence of each decision matrix *A*. A totally consistent matrix *A* has a CR equal 0. Notwithstanding a CR ratio less than 0.1 is acceptable [11].

In case of several decision makers the AHP method has tools to aggregate the expert's judgments, being the most extended method the geometric mean [11] which is done over the numeric entries of the paired comparisons by any single expert.

C. Dynamic fuzzy cognitive maps

The dynamic fuzzy cognitive maps is a qualitative approach to modelling a dynamic system, which helps structuring, analyzing and interpreting the mental model of an individual or group about certain domain, by using fuzzy signed directed graphs (i.e. digraphs) with feedbacks where world is represented as a collection of concepts and causal relation between them. Cognitive maps as a method for explicitly presenting concepts and casual assertions was originally developed by cognitive psychologists and is based on Kelly's personal construct theory [2]. Cognitive map works as a transitional object which can be applied by members in order to understand and think about their knowledge contents in relation to certain problem domains [2] and about their primary mechanisms and structures [6]. Cognitive maps can be categorised into five generic »families« [4]:

1. Maps that assess attention, association, and importance of concepts.
2. Maps that show dimension of categories and cognitive taxonomies.
3. Maps that show influence, causality, and system dynamics (causal maps).
4. Maps that show the structure of argument and conclusion.
5. Maps that specify frames and perceptual codes.

Fuzzy cognitive maps represent signed fuzzy digraphs and are classified in the third group among the five above referring groups. The main difference between crisp cognitive maps and fuzzy cognitive maps represents the fact, that in fuzzy cognitive maps the relation values are also defined. Fuzzy cognitive maps consist of nodes (also called points or units), which can capture values within the interval $[0,1]$ or $[-1,1]$, and casual connections or relations between nodes, which value can take any real number between zero and one. Nodes in the network represent events, benefits, objectives or other system components. The value a node achieves represents its state level in the certain moment *t*. Fuzzy cognitive maps use a threshold function *S* applied to the result of the matrix multiplication of the vector of initial states of variables and the adjacency matrix of causal connections weights, at each simulation step [5]. The threshold function serves to reduce unbounded inputs to a strict range.

Values of the node *i* in time *t* is represented by the state vector $C_i(t)$, and the state of the whole fuzzy cognitive map can be described by a state vector $\boldsymbol{C}(t) = (C_1(t),\dots,C_n(t))$, which represents a point within a fuzzy hypercube $I^n = [0,1]^n$ that system achieves at a certain point. The whole system with a certain starting state or input vector $\boldsymbol{C}(0)$ describes a time trace within a multidimensional space I^n, which can gradually converge to a strange (i.e. chaotic), point or periodic attractor within a fuzzy hypercube. To which attractor the system will converge depends of the value of the input vector $\boldsymbol{C}(0)$. However we cannot foresee to which attractor the system will converge as for the fuzzy cognitive maps the criteria of Lyapunov is not sufficient [5].

The value of the node C_i in a moment t_{n+1} we can calculate as a sum of all inputs in C_i which can be calculated as a product of the value of the cause node C_k in precedent moment t_n and the value of the cause-effect link e_{ki}. Mathematically we can describe this as:

$$C_i(t_{n+1}) = S\left[\sum_{k=1}^{N} e_{ki} \cdot C_k(t_n)\right]$$

The method we proposed is different from other fuzzy cognitive maps approaches because it can consider the time delay between cause and its effect as a time function. The value of the node *i* in the moment t_{n+1} we calculate as:

$$C_i(t_{n+1}) = S\left[\sum_{k=1}^{N} \mu_{ki}(t_n) \cdot C_k(t_n)\right]$$

where $\mu_{ki}(t_n)$ is a value of the effect of the node *k* on node *i* in the moment t_n. Value of the time function $\mu_{ki}(t)$ depends on function type. Mostly we use four different function types: step, linear, concave, convex and sigmoid. For a threshold function S we use a trivalent form of it as different empirical researches indicate that in this case is a low probability to converge to a chaotic attractor and at the same time the dynamics of the system is higher than in the case of bivalent threshold function S [5].

The simulation process is presented in the following steps:

- we define all nodes and we further classify them in a map;
- we define casual relations between nodes;
- we define the casual relation weights by using multiplicative AHP method (e_{ki});
- we define the adjacency matrix $\boldsymbol{E}$;
- we choose and define the time delay function and value for each effect according to our understanding;
- we define the time interval (dT) of each simulation step, which has to be lower or at most equal to half of the minimum time delay defined in the system;
- we transform the value stock that nodes can capture in the interval $[-1,1]$;
- we define the input vector $\boldsymbol{C}(0)$ (it is recommended that it reflects the current condition as best as possible);
- we implement the simulation until the network converges to one of the attractors or until we reach the setting time horizon.

The simulation, which is, with regard to the content, mainly qualitative, is not intended for forming exact quantitative values. First of all it is intended for identifying the pattern of system's behaviour, which is progressively formed according to given presumptions and which represents the value range that nodes of the map can achieve.

The whole process from design of the map to simulation performing is computer assisted. By use of the computer program we can graphically present and statically and dynamically analyze cognition map. After defining all variables, relationships between them and necessary values the simulation is carried out by use of the simulator. The simulator enables a progressive simulation from one period to another or direct transition to the last defined time period by copying out the results in the form of a text file. The scheme and obtained results can be saved and analyzed, modified, supplemented etc. again in the future.

III. GLOBAL SCENARIO: DEVELOPMENT AND CONTENT

A. Description of the work flow

The cognitive scheme, on which the simulation is based, has been developed according to the following steps:

1. We have identified the international experts from the field of sustainable development. The selection criteria were their research field, the importance of their contribution to the field, the number of published research papers in the field of sustainable development and global warming in the recent period, and their knowledge of Delphi Method. Three identified experts were willing to cooperate in the research. Two of them are university professors.
2. The first author of this paper in the role of the coordinator has sent the questionnaire to the members of the expert group. The questionnaire contained general questions about crucial social and economic factors, trends and directions, which should be included in the research. After the first round the coordinator has analyzed the answers and sent the results back to the members of the expert group. The members of the expert group have agreed about main factors in the second round. In the next round they have agreed about the span of values which can be captured by identified factors (see Table 15 at the Appendix).
3. After identifying crucial social and economic factors, trends and directions, the coordinator has requested the members of the expert group to define the causal map, which would graphically connect mentioned factors. The adjustment of the causal map requested three rounds of collective interactions.
4. After defining the causal map the members of the expert group were requested to make a pairwise comparison of identified factors as requested by multiplicative AHP. According to Delphi methodology, in each round, the consistent individual judgments a_{ij} were aggregated by use of geometric mean and reported into the next round questionnaire. In addition in each round the second questionnaire included the expert's judgments of the previous round and, in case of inconsistency, the reason for it. The consensus about values of mutual effects was formed in the third round of adjustments (see Table 1 to Table 14 at the Appendix).
5. According to the defined factors, their mutual effects and values different simulations were developed with different input values and time delays for independent factors. Regarding the content, simulations' results have varied the most from each other. The results of our simulations have been sent to the members of the expert group for judgment. They have ranked them according to the reliability of the acquired results. The ranks of particular group members with the explanation of their decision have been sent to the next rounds of adjustments. In the fourth round, the consensus has been agreed.

B. The cognitive map

The whole map is composed of twenty-eight factors (see Figure 1 at the Appendix). Between them only two factors are independent namely human consciousness and living standard. These two factors represent the most important levers of control within the designed system. Living standard has one positive and one negative effect within the system. The positive effect is that with the increase of the living standard the fertility rate declines and accordingly, the total population number stabilizes or grows slowly. The negative effect is that due to the rise in living standard the amount of solid waste, as well as energy demand increase because people want to buy cars, electric home appliances etc. On the other side the increase in human consciousness has only positive effects. If human consciousness is strongly present in society then emission standards are going to be more severe, pollution taxes are higher, more capital is invested in technology development, people produce less solid waste and they are more ready to use alternative fuels in exchange for conventional fuels. In one sense the most negative factor for global warming is the increase in population. A larger population increases food, energy, and living space demand and it also produces more solid waste. An increase in food, energy and living space demand has many different negative implications with maybe the most important deforestation. Deforestation is a direct consequence of higher food demand and related higher crop production and livestock breeding, as it is also an indirect consequence of living space and energy demand. As a result of deforestation we have less ecosystem variety and more soil erosion. Deforestation with all related factors is going to build up a self-sustained positive feedback loop, which starts with a need for more farmland to continue with deforestation and soil erosion to end again with a need for more farmland. Increase in population has also an indirect negative effect on disposable drink water as pesticides, fertilizers and solid waste are going to destroy sources of drink water. But maybe even bigger problem for future drink water supply is a shrink of glaciers as a result of global warming. In the proposed story we can see that technology can bring many different positive results regarding higher agricultural yields, less need for pesticides and fertilizers, higher energy efficiency, less solid waste, cheaper alternative fuels, and purification of waste water. However modern technology needs a huge amount of capital, which without a high level of human consciousness will never be disposable.

C. Simulation

Simulation (see Table 16 at the Appendix) is based on a supposition that human consciousness about global warming issues is high and will remain high. On the other side living standard is supposed to be in average. Because of that population is going at first to stabilize, which has many positive effects on energy demand. However conventional fuel is still a primary source of energy. Technology discoveries are going to increase in the first period and to stay at this level until period 4 when they decrease and stay at this average level from this point on. After six periods we can see that nodes' values achieve 0s or middle values except for human consciousness that is still high. We can understand this situation as a state where human consciousness cannot move the system further from this position. We can conclude based on our data that the future is not going to be so bad but also not very attractive. As we have all zeros for identified factors this indicate that after few years or so we will be able to stop negative climate processes but not able to fix the problem in the sense that we can substantially improve the situation we have now.

IV. ORGANISATIONAL AND TECHNOLOGICAL CHANGES FOR SUSTAINABLE DEVELOPMENT

According to the acknowledgments that were acquired through the simulation we suggest some organisational and technological changes that companies should make in order to achieve competitive advantage. It should be pointed out that simply executing these changes is not enough for achieving a sustainable competitive advantage. According to Porter [10] a company can achieve sustainable competitive advantage only by being unique. This uniqueness is evident when company offers special benefits to their stakeholders. This signifies the fact that when referring changes are adopted by the majority of companies in certain branch, they become standards. After that point they cannot represent the source of competitive advantage. They should be adopted in order to survive in the industry.

The first orientation, which emerges from the described development scenario, is the orientation towards the knowledge economy, which is, comparing to the industrial economy, more environmental friendly and less dependent on natural resources. The processes of knowledge management – creation, transfer, storage and application of the knowledge – require fewer natural resources in comparison to product manufacturing. The profitability of resources in knowledge economy is also higher than in production economy due to higher adding value. However a knowledge-era organisation cannot be defined in terms of the organisation's products, structure, systems or any other organisational characteristic. Rather, a knowledge-era organisation is one that exhibits a sense of pride and commitment. In a knowledge-era organisation people know and care what or why the organisation exists. An industrial-era organisation can then transform itself into a knowledge-era organisation if it can go beyond the strategy-structure-systems trilogy to establishing a sense of purpose [3].

The next proposed orientation is to become the proactive part of the knowledge network that is supported by information and communication technology. These networks are reshaping classical and rigid organisational borders with exact definition of who/what form the constitutive part of the organisation and who/what are subjects of external environment (for example competitors, suppliers, consumers etc.). In traditional supply and demand market economy, all mentioned subjects were individually competing on the market in order to buy as cheaper as possible and to sell as expensive as possible. In the knowledge network this rule does not work any more. Different organisations represent different parts of the network and they interact with each other in order to develop new knowledge. This knowledge is now not a private property of certain organisation but presents the property of the whole network. Such examples of cooperation can be nowadays already found in different companies, where suppliers and consumers closely cooperate with the organisation in the process of new product development. Such cooperation can be effective only when the knowledge flow is not in any way interrupted between the group members, even if they are members of different organisations. For that reason is trust the essential element of a successful network. A higher stage of cooperation within the knowledge network is represented by a sort of open code solutions. At this stage the knowledge network is by definition boundless and unlimited. Everyone who has interest can take part in the development process. Basically this presents an extended concept of communities of practice that is beyond the boundary of one or more organizations. A knowledge network can be defined as a self-organized community, which has the intention to form and develop new knowledge on the basis of common interests.

The referring orientations are corresponding to the concept of human capital. This concept is not focused solely on implementing traditional human resource policies (employment, promotion, awarding of employees). It is focused on stimulating and creating social environment, where employees can gain new knowledge, develop their own ideas from the basic concept to the prototype development and grow as persons. To establish such a social environment we need to transform the traditional organisational structures into more flexible forms of cooperation on the basis of common interests and development projects; i.e. we need to move from formal organisation or units to "informal" communities as we said before. Nevertheless the hierarchical structures in companies should not be abolished; they are presented in every natural or social system. Hierarchical structures should only be minimized in order to avoid negative selection. The negative selection is evident when certain employees are promoted in spite of their incompetence, solely because they smoothly assent to any idea and decision of their superiors. On the other hand the employees who are creative and who defend firmly their ideas can be punished and are not promoted. In the future different type of employees is required; they need to be more educated, more flexible to adapt to quick and radical changes, and prepared to take responsibility for their decisions and actions. Above all they need to have the desire to learn and to gain new knowledge.

V. CONCLUSIONS

In this paper a hybrid approach to scenario planning by integrating group Delphi method, AHP (Analytic Hierarchy Process) and dynamic fuzzy cognitive maps has been proposed. Due to the importance of sustainable development for the future of the world we tried to contribute to the understanding of the issue and to propose some possibly changes organisation can do to improve the actual situation.

According to Li et al. [7] the driving forces for using hybrid approaches are: to achieve methods enhancement as we want to avoid the weaknesses of individual methods while combining their strengths; and to achieve multiplicity of application tasks as no single method is adequate to deal with different sub-problems of the given task. In the authors' opinion, this hybrid approach extends the limits of all three isolated methodologies for supporting scenarios development. Nevertheless, this approach has also some limitations especially in case of a larger number of factors. This is because of the large number of pairwise comparisons we need to perform. Beside that it can be also difficult to design measures for all involved factors in a way that measures properly represent a relationship between cause and effect. Sometimes is also difficult to define a starting value for a factor as not all values are available especially for some qualitative measures.

Hopefully the proposed approach will be applied by other researchers on climate related issues and in this way some new knowledge related to this critical issue for all people will develop.

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APPENDIX

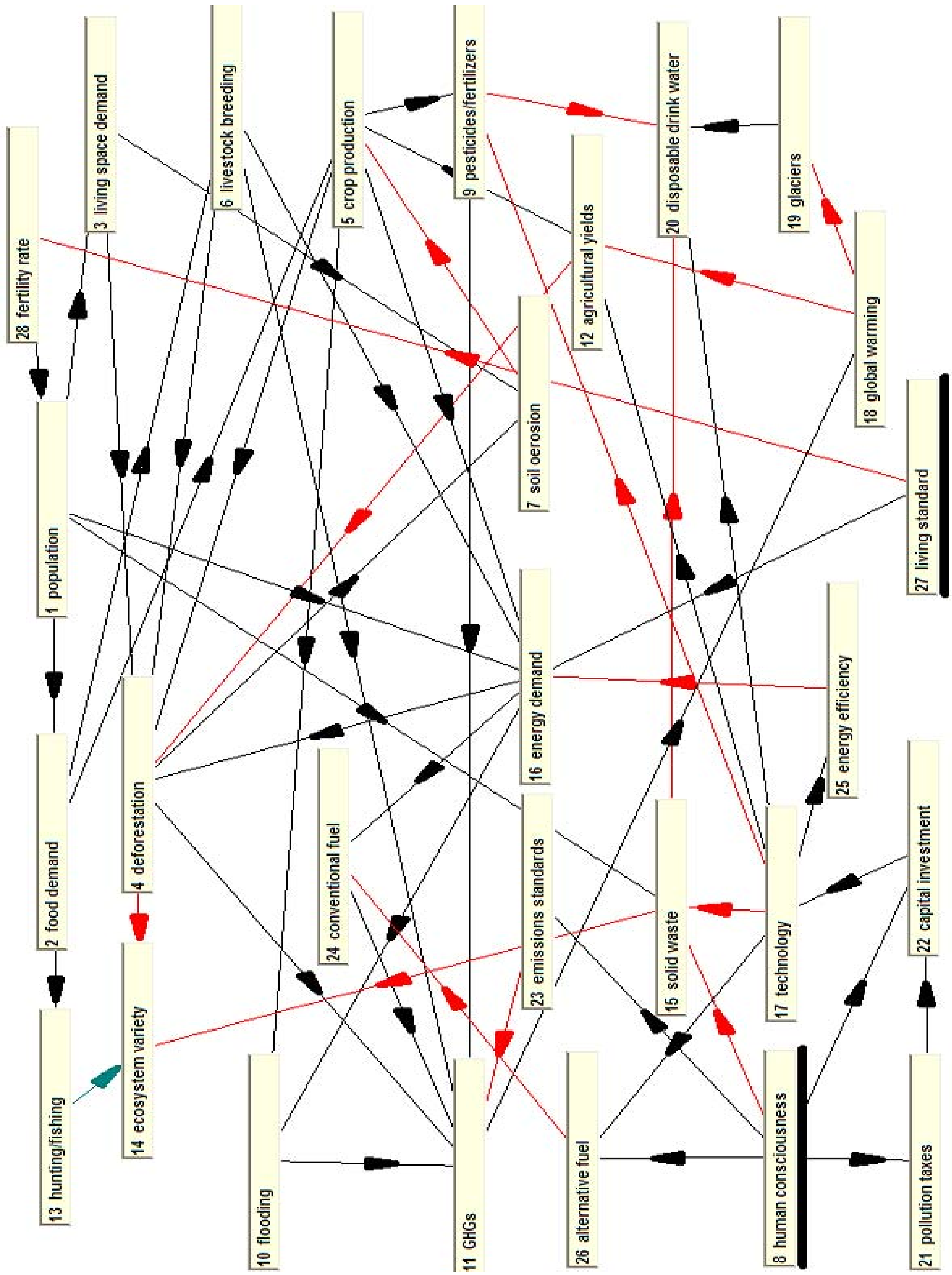

Figure 1: Cognitive map for scenario development

TABLE 1: PAIRWISE COMPARISON MATRIX FOR ECOSYSTEM VARIETY

Ecosystem variety	Hunting/ Fishing	Deforestation	Solid waste	**Weights**
Hunting/ Fishing	0	-4	-2	0.054
Deforestation	4	0	2	0.86
Solid waste	2	-2	0	0.086

TABLE 2: PAIRWISE COMPARISON MATRIX FOR DEFORESTATION

Deforestation	Living space demand	Livestock breeding	Crop production	Agricultural yields	Energy demand	**Weights**
Living space demand	0	4	4	6	4	0.786
Livestock breeding	-4	0	0	4	2	0.086
Crop production	-4	0	0	4	2	0.086
Agricultural yields	6	-4	-4	0	-4	0.005
Energy demand	-4	-2	-2	4	0	0.037

TABLE 3: PAIRWISE COMPARISON MATRIX FOR FLOODING

Flooding	Crop production	Energy demand	**Weights**
Crop production	0	-2	0.2
Energy demand	2	0	0.8

TABLE 4: PAIRWISE COMPARISON MATRIX FOR CROP PRODUCTION

Crop production	Soil erosion	Agricultural yields	Food demand	**Weights**
Soil erosion	0	2	-4	0.06
Agricultural yields	-2	0	-6	0.014
Food demand	4	6	0	0.926

TABLE 5: PAIRWISE COMPARISON MATRIX FOR GHGS

GHGs	Flooding	Defores-tation	Conventional fuel	Livestock breeding	Pesticides/ Fertilizers	Emission standards	**Weights**
Flooding	0	0	-8	-2	2	2	0.02
Deforestation	0	0	-4	-2	2	4	0.041
Conventional fuel	8	4	0	4	4	6	0.82
Livestock breeding	2	2	-4	0	4	4	0.103
Pesticides/ Fertilizers	-2	-2	-4	-4	0	0	0.01
Emission standards	-2	-4	-6	-4	0	0	0.006

TABLE 6: PAIRWISE COMPARISON MATRIX FOR PESTICIDES

Pesticides	Crop production	Technology	**Weights**
Crop production	0	4	0.94
Technology	-4	0	0.06

TABLE 7: PAIRWISE COMPARISON MATRIX FOR SOIL EROSION

Soil erosion	Living space demand	Deforestation	**Weights**
Living space demand	0	2	0.8
Deforestation	-2	0	0.2

TABLE 8: PAIRWISE COMPARISON MATRIX FOR ENERGY DEMAND

Energy demand	Energy efficiency	Livestock breeding	Crop production	Population	Living standard	**Weights**
Energy efficiency	0	6	4	4	-2	0.284
Livestock breeding	-6	0	-2	-4	-8	0.003
Crop production	-4	2	0	-2	-6	0.006
Population	-4	4	2	0	-2	0.054
Living standard	2	8	6	2	0	0.653

TABLE 9: PAIRWISE COMPARISON MATRIX FOR ALTERNATIVE FUELS

Alternative fuel	Human consciousness	Technology	**Weights**
Human consciousness	0	-4	0.06
Technology	4	0	0.94

TABLE 10: PAIRWISE COMPARISON MATRIX FOR SOLID WASTE

Solid waste	Soil erosion	Agricultural yields	Food demand	**Weights**
Technology	0	-2	-4	0.035
Human consciousness	2	0	-4	0.087
Population	4	4	0	0.878

TABLE 11: PAIRWISE COMPARISON MATRIX FOR CAPITAL INVESTMENT

Capital investment	Human consciousness	Pollution taxes	**Weights**
Human consciousness	0	-6	0.015
Pollution taxes	6	0	0.985

TABLE 12: PAIRWISE COMPARISON MATRIX FOR AGRICULTURAL YIELDS

Agricultural yields	Technology	Global warming	**Weights**
Technology	0	-4	0.06
Global warming	4	0	0.94

TABLE 13: PAIRWISE COMPARISON MATRIX FOR CONVENTIONAL FUEL

Conventional fuel	Alternative fuel	Energy demand	**Weights**
Alternative fuel	0	-2	0.2
Energy demand	2	0	0.8

TABLE 14: PAIRWISE COMPARISON MATRIX FOR DISPOSABLE DRINK WATER

Disposable drink water	Technology	Glaciers	Pesticides/ Fertilizers	Solid waste	**Weights**
Technology	0	-4	-2	-2	0.03
Glaciers	4	0	4	4	0.83
Pesticides	2	-4	0	0	0.07
Solid waste	2	-4	0	0	0.07

TABLE 15: RANGE VALUES AND INPUT VALUE OF IDENTIFIED FACTORS

Factor	**Range values**	**Starting value**
Population (billion)	5-8.5	6.6
Food demand (million ton)	2000-3500	2500
Living space demand	1-10	5
Deforestation	1-10	5
Crop production (million ton)	1800-2500	2000
Livestock breeding (billion)	1.1-1.5	1.3
Soil erosion	1-10	5
Human consciousness	1-10	10
Pesticides/ Fertilizers (billion US$)	30-35	31.5
Flooding	1-10	5
GHGs (CO_2 ppm)	250-600	350
Agricultural yields (% change)	-10-15	0
Hunting/fishing (million ton)	30-35	31.5
Ecosystem variety	-5-5	0
Solid waste (billion ton / year)	2.4-4.8	3.3
Energy demand (TW)	12.5-16	13.5
Technology	1-10	5
Global warming (^{o}C)	0-2.5	1.1
Glaciers (million km^3)	21-26	24
Disposable drink water (000 km^3 / year)	39-44	42.5
Pollution taxes	1-10	5
Capital investment (billion / year)	0-5.5	3.5
Emission standards	1-10	5
Conventional fuel (million ton)	4500-7000	5500
Energy efficiency	0.5-2.2	1.1
Alternative fuel (million ton oil equivalent)	1000-3500	2000
Living standard (household income 000 $)	30-60	45
Fertility rate (children/woman)	2.5-3.5	3

TABLE 16: RESULTS OF THE SIMULATION (1 PERIOD = 1 YEAR)

Period 1

1	1	1	1	1	1	1	1	1	1	1	-1	1	-1	0	1	1	1	-1	1	1	1	1	-1	1	1	0	-1

Period 2

-1	1	1	1	1	1	1	1	1	1	-1	-1	1	-1	1	0	1	1	-1	-1	0	1	0	1	1	1	0	0

Period 3

0	-1	-1	1	1	1	1	1	1	0	1	-1	1	-1	-1	0	1	-1	-1	-1	0	0	0	0	1	1	0	0

Period 4

0	0	0	-1	-1	-1	-1	1	1	0	0	1	-1	-1	0	0	0	1	1	-1	0	0	0	0	1	1	0	0

Period 5

0	0	0	0	0	0	0	1	-1	0	0	-1	0	1	0	0	0	0	-1	1	0	0	0	0	0	0	0	0

Period 6

0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0

Period 7

0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Period 8

0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0