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Models of Strategic Management Scanning Based on Trend Heuristics as the Least Information Intensive Quantifiers

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ABSTRACT

SS (Strategic Scanning) is unique, partially subjective, inconsistent, interdisciplinary, vague and multidimensional process. Its description and optimisation suffers from IS (Information Shortage) and heterogeneity. IS eliminates straightforward application of traditional statistical methods. Heterogeneity problems are caused by heterogeneous nature of scanned information structures. Artificial Intelligence has developed some tools to solve such problems. Qualitative reasoning is one of them. It is based on the least information intensive quantifiers i.e. trends. There are four different trends i.e. qualitative values and their derivatives: plus/increasing; zero/constant; negative/decreasing; any value / any trend. The paper studies SS models based on ELEs (Equationless Heuristics). An example of ELE is – If novelity is increasing then confidence is decreasing. A solution of a qualitative model is represented by a set S of scenarios and a set T of time transitions among these scenarios. The key information input into an ELE model is subjective knowledge of experts. A consensus among SS experts is often not reached because of inconsistencies of experts' knowledge. The SS case study is 12 dimensional (e.g. Freshness, Relevance) and based on 12 ELEs. There are 29 scenarios.

Keywords: strategic, scanning, trend, transition, information shortage, complex.
JEL classification: C63; M00.
MSC2010: O3B52.

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Modelos de escaneo de gestión estratégica basados en tendencias heurísticas como cuantificadores intensivos de menor información

RESUMEN

SS (Strategic Scanning) es un proceso único, parcialmente subjetivo, inconsistente, interdisciplinario, vago y multidimensional. Su descripción y optimización adolece de IS (escasez de información) y heterogeneidad. IS elimina la aplicación directa de los métodos estadísticos tradicionales. Los problemas de heterogeneidad son causados por la naturaleza heterogénea de las estructuras de información escaneadas. La Inteligencia Artificial ha desarrollado algunas herramientas para resolver tales problemas. El razonamiento cualitativo es uno de ellos. Se basa en los cuantificadores que requieren menos información, es decir, las tendencias. Hay cuatro tendencias diferentes, es decir, valores cualitativos y sus derivados: más / creciente; cero / constante; negativo / decreciente; cualquier valor / cualquier tendencia. El artículo estudia los modelos SS basados en ELE (heurística sin ecuaciones). Un ejemplo de ELE es: si la novedad aumenta, la confianza disminuye. La solución de un modelo cualitativo está representada por un conjunto S de escenarios y un conjunto T de transiciones de tiempo entre estos escenarios. La entrada de información clave en un modelo ELE es el conocimiento subjetivo de los expertos. A menudo no se llega a un consenso entre los expertos en SS debido a inconsistencias en el conocimiento de los expertos. El estudio de caso de SS es de 12 dimensiones (por ejemplo, Frescura, Relevancia) y se basa en 12 ELE. Hay 29 escenarios.

Palabras clave: estratégico, escaneo, tendencia, transición, escasez de información, complejo.
Clasificación JEL: C63; M00.
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1. Introduction.

Important tasks of any strategic management are abilities of managers to anticipate opportunities and threats (Seidl & Werle, 2017). An important tool is a strategic scanning (SS). The SS involves watching important events and trends in the environment. Many studies have discussed the methods that managers use to scan (Lesca, Caron-Fasan & Falcy, 2012).

Any efficient scanning method must reflex the very nature of the scanned networks of different information items that are related to strategic management. These networks are based on extremely heterogeneous items usually a mixture of deep and shallow knowledge items.

Deep knowledge items are such laws, which reflect undisputed elements of the corresponding theory (Russel, 1948). The Newton laws are examples of deep knowledge items. A deep knowledge item is available in a form of a set of equations A shallow knowledge item is a heuristic or a result of a statistical analysis of observations and has (many) exceptions (Michalewicz & Fogel, 2004). There are very few SS deep knowledge items.

Numbers are precise. SS based exclusively on numbers is often prohibitively information intensive. Therefore, less information intensive quantifiers (fuzzy, rough, semi qualitative, verbal) are used (Dohnal, Kocmanová & Rášková, 2008; Parsons, Kubat & Dohnal, 1995; Zhang et al., 2015; Singh & Dey, 2005).

The law of large numbers specify the conditions under which probabilities can be safely evaluated (Loève, 1977; Sen & Singer, 1993). High numbers of available observations is atypical for SS. Information intensity of traditional statistical analysis generates pressure on artificial intelligence community to develop new formal tools or newly upgrade older tools, which are not as objective as statistics but can take into consideration such information items as ELEs. An example of ELE is:

If a novelty of an information items is increasing then its confidentiality is decreasing.

SS experts do not use mathematical models as the basic framework for their reasoning (Walters, Jiang & Klein, 2003; Lesca et al., 2012; Hendry, 1995; Hayes, 1985a, 1985b). Experts draw heavily on common-sense (Mueller, 2014; Dohnal, 1988).

The correct / not bad choice of the formal SS tool depends on the structure and types of available knowledge item networks. These networks incorporate ad hoc mixtures of the following information items:

- dominantly subjective information usually formalised by verbal descriptions
  - experience
  - analogy
  - feelings

- mathematical models - deep knowledge items based on generally accepted laws, e.g. sets of differential equations (1)
  - unknown numerical values of parameters
  - known values of constants and parameters

- statistical models - shallow knowledge items, e.g. a polynomial function based on the least squares algorithm
  - original data sets are available
  - no original data sets are available
  - with partial data set availability

There are two key scanning problems: *Information shortages* and *knowledge heterogeneity*. They are closely interconnected. The heterogeneity can be easily eliminated by ignoring such segments of available information items, which cannot be treated by chosen formal SS tools. For example, verbal quantifications cannot be used for conventional statistical analysis. A relatively specific problem of IPO (Initial public offering) is an example of complex integration of Information shortages and knowledge heterogeneity (Meluzin & Zinecker, 2014).

If some information segments are ignored then the information shortages are increased. Therefore, an ad hoc optimal *Information shortage* / *Heterogeneity* trade-off must be chosen, for example:

Minimal Information shortage and Maximal Heterogeneity

Maximal Information shortage and Minimal Heterogeneity

A trend - *increasing, decreasing, constant* - is the least information intensive quantifier. If trend cannot be quantified then nothing can be measured / observed. Models based on trends are usually used to formalize dominantly subjective information (1).

Strategic decision-making necessitates systematic use of the best possible emerging information on potential opportunities, obstacles and change (Garnett et al., 2016). There are different interpretations of SS (Van Wyk, 1997). However, the goal of SS studied in this paper is a trend identification and use of networks of different knowledge and/or information items (Myers & Newman, 2007; Ramakrishnan, Jones & Sidorova, 2012). These trends are used to eliminate bad decisions based on vaguely known / partially expected threats (Walters et al., 2003; Lesca et al., 2012).

2. Trend Knowledge and Trend Models.

The idea of trends is indirectly used to formalize different types of supports and / or reductions, for example mutual supports and reductions among such vague variables as e.g. Mindfulness, Assimilation, IT Turbulence, etc. (see Fig. 1 in Mu, Kirsch & Butler, 2015).

The following pairwise direct and indirect proportionalities / relations between two variables X and Y are studied in this paper:

An increase in (X) has a supporting effect on (Y) and vice versa. (2)
An increase in (X) has a reducing effect on (Y) and vice versa.

The following relations will be used to develop trend models based exclusively on trend proportionalities (2):

SUPPORTING X Y (3)

REDUCING X Y

For example:

If OC (Oil Cost) is increasing then the OD (Oil Demand) is decreasing. (4)

The knowledge item (4) is transformed into, see (3):

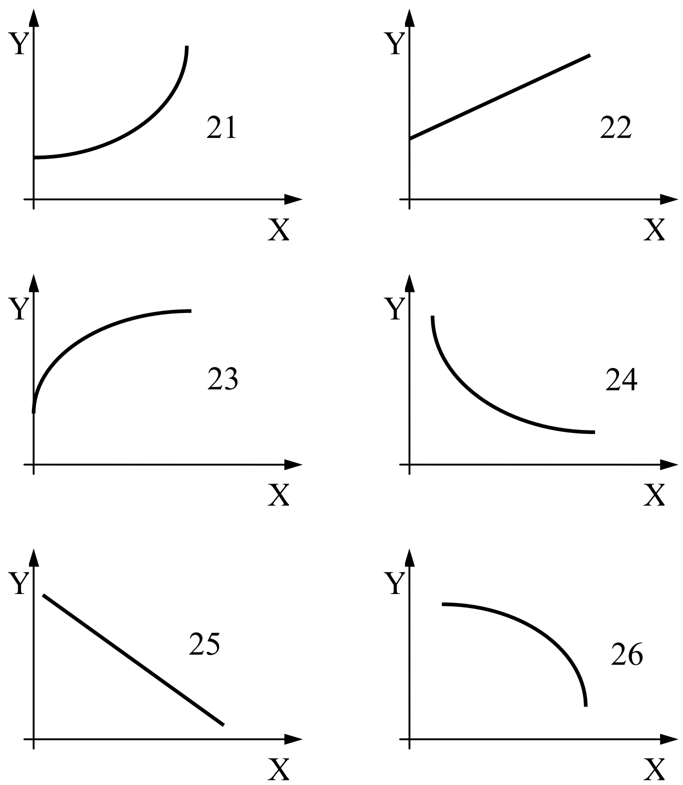
REDUCING *OC* *OD* (5)

The relation (4) is based just on the first derivative:

$d(OD) / d(OC)$ = negative (6)

The SS models presented in this paper are based on pair wise trend relations. Examples of equationless pair wise trend / qualitative relations are given in Figure 1.

Figure 1. Examples of qualitative pair wise relations.



Source: Own elaboration.

All pair wise relations in Figure 1 are trend relations, i.e. the only quantifiers are: *increasing, constant, decreasing* (Dohnal, 1991). For example, the relation No. 24 indicates that the relation $Y = f(X)$:

- is decreasing, the first derivative dY/dX is negative (7)
- the decrease is slowing down, i.e. the second derivative d^2Y/dX^2 is positive, there is obviously an quantitatively unknown lower limit Y_{lower}
- if $X = 0$ then $Y > 0$.

For example, the following ELE:

If a Novelty X of an information items is increasing then its Confidentiality/Reliability Y is decreasing more and more rapidly. (8)

is represented by the shape No. 26 (Figure 1). Trend hypothesis are frequently available in literature, see e.g. (Cai et al., 2016; Young, 1987).

3. Equationless SS Models.

Human brains can solve SS tasks which are out of reach of computer based algorithms. Human-like common sense theories have attracted extensive attention long time ago (Lipmann & Bogen, 1923; Kuipers, 1994). Qualitative reasoning is a part of it (de Kleer & Brown, 1984).

There are only four qualitative values:

Positive	Zero	Negative	Any Value	
+	0	-	*	(9)

A simple transfer of numerical derivative time dx_i/dt to the qualitative derivatives DX is:

$$\begin{aligned} &\text{if } dx_i / dt > 0 \text{ then } DX_i = + \\ &\text{if } dx_i / dt = 0 \text{ then } DX_i = 0 \\ &\text{if } dx_i / dt < 0 \text{ then } DX_i = - \end{aligned} \tag{10}$$

A qualitative model M(X) is based on n-dimensional vector X of qualitative variables (Lorenz, 1989; Ljung, 1999):

$$M(X_1, X_2, \ldots, X_n) = 0 \tag{11}$$

A set S of qualitative scenarios is a solution of a model M (11). A qualitative n-dimensional scenario is described by a set of qualitative triplets (X, DX, DDX):

$$S = [(X_1, DX_1, DDX_1), (X_2, DX_2, DDX_2), \ldots (X_n, DX_n, DDX_n)]_j \; ; j = 1, 2, \ldots, m \tag{12}$$

where, *DX* is the first and *DDX* is the second time qualitative derivatives.

SS related theory and available knowledge items usually do not allow quantification of the third and higher derivatives. This is the key reason why just the second derivatives are taken into account (12).

An equationless SS qualitative model based on ELEs is a set of w pairwise relations (see Fig. 1):

$$P_s (X_i, X_j); \; s = 1, 2, \ldots\ldots w \tag{13}$$

The set of relations (13) can be solved to evaluate all such scenarios which satisfy the relevant model. For example, the following simple set of two relations is studied:

	Shape	X	Y , see Fig. 1	
1	22 (see Fig. 1)	X_1	X_2	(14)
2	26 (see Fig. 1)	X_3	X_2	

An algorithm which can be used to solve the model (14) is based on pruning of a specially generated tree. It is not the goal of this paper to describe such algorithm as it is a purely combinatorial task, see e.g. (Vicha & Dohnal, 2008).

To simplify the problem, let us suppose that all three variables X_1, X_2 and X_3 (14) are positive. For example, X_1 is an investment and this is always positive. Therefore the following triple is used $(+, DX_1, DDX_1)$, where DX_1 is the first and DDX_1 is the second derivative of X_1 (12).

Another simplification is that the second derivative is ignored if the studied SS information / knowledge items are so poor that the second derivatives cannot be evaluated. It means that just the following triplet is used:

$$(+, DX_1, \text{Ignore}) = (+, DX_1, *), \text{ see (9)} \quad (15)$$

If the second derivatives are ignored or unknown then the model (14) cannot be described by the shapes given in Fig. 1. Qualitative proportionalities are therefore introduced *3). DQP is the direct qualitative proportionality and IQP is the indirect qualitative proportionality:

DQP If *X* is increasing then Y is increasing
If *X* is decreasing then Y is decreasing DX = DY (16)

IQP If *X* is increasing then Y is decreasing
If *X* is decreasing then Y is increasing DX = - DY

DQP represents the following three shapes, see Fig. 1: 21, 22, and 23. IQP represents 24, 25, and 26. If a SS information item is so vague that it is not possible distinguish the shapes 21, 22 and 23 then DQP (9) is used.

4. Transitional Graphs.

The set of scenarios S (12) is not the only result of SS qualitative models. It is possible to evaluate transition among a set of scenarios S (12).

A complete set of all possible one-dimensional transitions is given in Table 1.

Table 1. A list of all one-dimensional transitions.

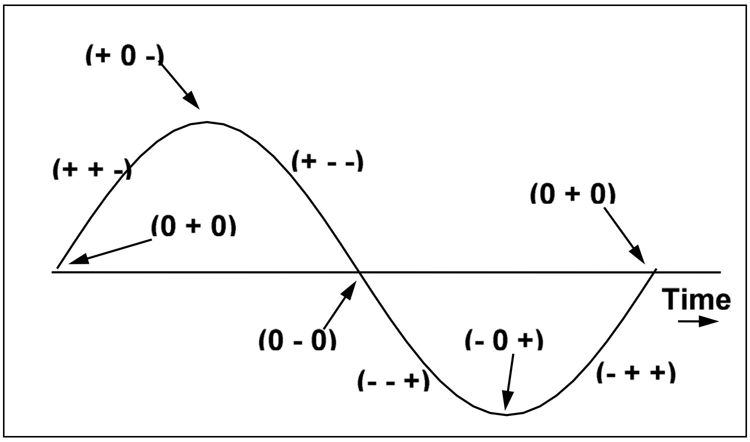
	From		a	b	c	d	e	f	g
1	+ + +	→	+ + 0						
2	+ + 0	→	+ + +	+ + -					
3	+ + -	→	+ + 0	+ 0 -	+ 0 0				
4	+ 0 +	→	+ + +						
5	+ 0 0	→	+ + +	+ - -					
6	+ 0 -	→	+ - -						
7	+ - +	→	+ - 0	+ 0 +	+ 0 0	0 - +	0 0 +	0 0 0	0 - 0
8	+ - 0	→	+ - +	+ - -	0 - 0				
9	+ - -	→	+ - 0	0 - -	0 - 0				
10	0 + +	→	+ + 0	+ + -	+ + +				
11	0 + 0	→	+ + 0	+ + -	+ + +				
12	0 + -	→	+ + -						
13	0 0 +	→	+ + +						
14	0 0 0	→	+ + +	- - -					
15	0 0 -	→	- - -						
16	0 - +	→	- - +						
17	0 - 0	→	- - 0	- - +	- - -				
18	0 - -	→	- - 0	- - +	- - -				
19	- + +	→	- + 0	0 + +	0 + 0				
20	- + 0	→	- + -	- + +	0 + 0				
21	- + -	→	- + 0	- 0 -	- 0 0	0 + -	0 0 -	0 0 0	0 + 0
22	- 0 +	→	- + +						
23	- 0 0	→	- + +	- - -					
24	- 0 -	→	- - -						

25	- - +	→	- - 0	- 0 +	- 0 0				
26	- - 0	→	- - -	- - +					
27	- - -	→	- - 0						

Source: Own elaboration.

For example, the 7-th line of Tab. 1 indicates that it is possible to transfer the triplet (+ - +) (12) into the triplet (+ - 0). This transition is not the only possible. There are six more possible transitions. Figure 2 gives, as an example a qualitative description of an oscillation.

Figure 2. Qualitative one-dimensional time record of an oscillation.



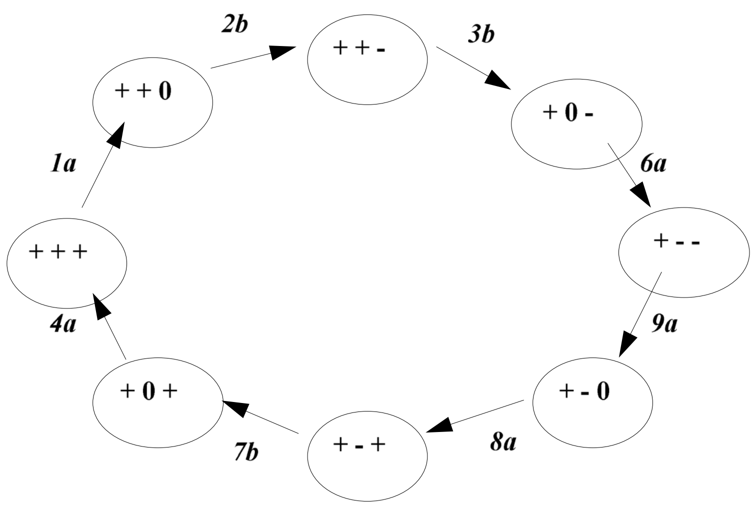
Source: Own elaboration.

A transitional graph *G* is an oriented graph. Its nodes are the set of scenarios *S* (12) and oriented arcs are the transitions *T*:

$$G(S, T) \tag{17}$$

To demonstrate a simplicity of qualitative models, let us suppose that the oscillation, see Fig. 2, takes place in the positive values only. The transitional graph G (17) based on the modified set of scenarios given in Fig. 2 is represented by the transitions given in Figure 3 (see Table 1):

Figure 3. Transitional graph of an oscillation.



Source: Own elaboration.

For example, the one-dimensional transition (+ + -) → (+ 0 -) is done using the 3-rd line of Table 1 and its b-th column.

Figure 3 represents a transitional graph with 8 scenarios and 8 transitions T (17).

5. Case Study.

SSs can be described by a broad spectrum of models and specific variables. The following set of SS features / parameters is used in this paper, for details see (Lesca et al., 2012):

Variable	Abbreviation	Short Characteristic	
Reliability	RE	How much confidence can we have?	
Novelty	NO	Is the message new to me?	
Freshness	FR	Is this information fresh?	
Repetition	RP	Is this information repeatedly available?	(18)
Relevance	RL	Does this information concern my environment?	
Importance	IM	Does this information concern circumstances likely to have a strong impact?	
Opportunity	OP	An opportunity for my company	
Risk	RI	There is a threat to my company?	
Reactivity	RA	Swift action is required	
Substitution	SU	Current strengths of my competitive position could be replaced	
Surprise	SR	Do I find this information surprising, unexpected or strange?	
Variety	VA	Does this information bring to mind multiple plausible developments?	

The qualitative definition of a variable does not require the relevant dimension.

The model, developed by a team of expert using the conclusions given in (Lesca et al., 2012), is represented by 12 ELEs, w = 12 (13).

see Fig. 1		X	Y	
1	26	NO	RE; see (18)	
2	25	RE	FR	
3	26	RP	NO	
4	21	RP	RE	
5	21	IM	RL	
6	23	OP	IM	(19)
7	DQP see (16)	RL	OP	
8	DQP	RA	OP	
9	DQP	RI	RE	
10	IQP	SU	RL	
11	DQP	VA	NO	
12	IQP	SR	RP	

The ELEs model (19) incorporates relations Nos. 7 - 12 that are based on qualitative proportionalities (16). It means that the team of experts was not able to choose the relevant qualitative shapes from Fig. 1.

The first version of a qualitative model often contains inconsistencies and has no therefore solution (Dohnal, 1988). If the solution of the model (19) is based just on the first derivatives, see (+, evaluate, ignore), then it is easier to identify and eliminate all inconsistencies. There are no inconsistencies in the model (19).

There are just three scenarios (m = 3, (12)) if the triplets (+, evaluate, ignore *) (15) are considered:

	RE	NO	FR	RP	RL	IM	OP	RI	RA	SU	SR	VA, see (18)	
1	++*	+-*	+-*	++*	++*	++*	++*	++*	++*	+-*	+-*	+-*	
2	+0*	+0*	+0*	+0*	+0*	+0*	+0*	+0*	+0*	+0*	+0*	+0*	(20)
3	+-*	++*	++*	+-*	+-*	+-*	+-*	+-*	+-*	++*	++*	++*	

The second scenario (20) is the steady state scenario - all the first derivatives are zeros.

If the second derivatives are taken into consideration then the following set of 29 scenarios is obtained as the solution of the model (19):

	RE	NO	FR	RP	RL	IM	OP	RI	RA	SU	SR	VA
1	+++	+--	+--	+++	+++	+++	+++	+++	+++	+--	+--	+--
2	+++	+--	+--	+++	+++	++0	+++	+++	+++	+--	+--	+--
3	+++	+--	+--	+++	+++	++-	+++	+++	+++	+--	+--	+--
4	+++	+--	+--	++0	+++	+++	+++	+++	+++	+--	+-0	+--
5	+++	+--	+--	++0	+++	++0	+++	+++	+++	+--	+-0	+--
6	+++	+--	+--	++0	+++	++-	+++	+++	+++	+--	+-0	+--
7	+++	+--	+--	++-	+++	+++	+++	+++	+++	+--	+-+	+--
8	+++	+--	+--	++-	+++	++0	+++	+++	+++	+--	+-+	+--
9	+++	+--	+--	++-	+++	++-	+++	+++	+++	+--	+-+	+--
10	++0	+--	+-0	++-	++0	++-	++0	++0	++0	+-0	+-+	+--
11	++-	+-+	+-+	++-	++-	++-	++-	++-	++-	+-+	+-+	+-+
12	++-	+-0	+-+	++-	++-	++-	++-	++-	++-	+-+	+-+	+-0
13	++-	+--	+-+	++-	++-	++-	++-	++-	++-	+-+	+-+	+--
14	+0+	+0-	+0-	+0+	+0+	+0+	+0+	+0+	+0+	+0-	+0-	+0-
15	+00	+00	+00	+00	+00	+00	+00	+00	+00	+00	+00	+00
												(21)
16	+0-	+0+	+0+	+0-	+0-	+0-	+0-	+0-	+0-	+0+	+0+	+0+
17	+-+	++-	++-	+-+	+-+	+-+	+-+	+-+	+-+	++-	++-	++-
18	+-+	++-	++-	+-+	+-+	+-0	+-+	+-+	+-+	++-	++-	++-
19	+-+	++-	++-	+-+	+-+	+--	+-+	+-+	+-+	++-	++-	++-
20	+-+	++-	++-	+-0	+-+	+-+	+-+	+-+	+-+	++-	++0	++-
21	+-+	++-	++-	+-0	+-+	+-0	+-+	+-+	+-+	++-	++0	++-
22	+-+	++-	++-	+-0	+-+	+--	+-+	+-+	+-+	++-	++0	++-
23	+-+	++-	++-	+--	+-+	+-+	+-+	+-+	+-+	++-	+++	++-
24	+-+	++-	++-	+--	+-+	+-0	+-+	+-+	+-+	++-	+++	++-
25	+-+	++-	++-	+--	+-+	+--	+-+	+-+	+-+	++-	+++	++-
26	+-0	++-	++0	+--	+-0	+--	+-0	+-0	+-0	++0	+++	++-
27	+--	+++	+++	+--	+--	+--	+--	+--	+--	+++	+++	+++
28	+--	++0	+++	+--	+--	+--	+--	+--	+--	+++	+++	++0
29	+--	++-	+++	+--	+--	+--	+--	+--	+--	+++	+++	++-

However, no consensus among the experts was achieved. A subset of experts replaced the relations 11 and 12 of the model (19) by the following relations:

11 DQP	VA	RL	(22)
12 DQP	RI	SR	

The modified model (22) was solved and the following set of 25 scenarios was generated:

	RE	NO	FR	RP	RL	IM	OP	RI	RA	SU	SR	VA
1	+++	+--	+--	+++	+++	+++	+++	+++	+++	+--	+++	+++
2	+++	+--	+--	+++	+++	++0	+++	+++	+++	+--	+++	+++
3	+++	+--	+--	+++	+++	++-	+++	+++	+++	+--	+++	+++
4	+++	+--	+--	++0	+++	+++	+++	+++	+++	+--	+++	+++
5	+++	+--	+--	++0	+++	++0	+++	+++	+++	+--	+++	+++
6	+++	+--	+--	++0	+++	++-	+++	+++	+++	+--	+++	+++
7	+++	+--	+--	++-	+++	+++	+++	+++	+++	+--	+++	+++
8	+++	+--	+--	++-	+++	++0	+++	+++	+++	+--	+++	+++
9	+++	+--	+--	++-	+++	++-	+++	+++	+++	+--	+++	+++
10	++0	+-0	+-0	++-	++0	++-	++0	++0	++0	+-0	++0	++0
11	++-	+-+	+-+	++-	++-	++-	++-	++-	++-	+-+	++-	++-
12	+0+	+0-	+0-	+0+	+0+	+0+	+0+	+0+	+0+	+0-	+0+	+0+
13	+00	+00	+00	+00	+00	+00	+00	+00	+00	+00	+00	+00
14	+0-	+0+	+0+	+0-	+0-	+0-	+0-	+0-	+0-	+0+	+0-	+0-
15	+-+	++-	++-	+-+	+-+	+-+	+-+	+-+	+-+	++-	+-+	+-+
16	+-+	++-	++-	+-+	+-+	+-0	+-+	+-+	+-+	++-	+-+	+-+
17	+-+	++-	++-	+-+	+-+	+--	+-+	+-+	+-+	++-	+-+	+-+
18	+-+	++-	++-	+-0	+-+	+-+	+-+	+-+	+-+	++-	+-+	+-+
19	+-+	++-	++-	+-0	+-+	+-0	+-+	+-+	+-+	++-	+-+	+-+
20	+-+	++-	++-	+-0	+-+	+--	+-+	+-+	+-+	++-	+-+	+-+
21	+-+	++-	++-	+--	+-+	+-+	+-+	+-+	+-+	++-	+-+	+-+
22	+-+	++-	++-	+--	+-+	+-0	+-+	+-+	+-+	++-	+-+	+-+
23	+-+	++-	++-	+--	+-+	+--	+-+	+-+	+-+	++-	+-+	+-+
24	+-0	++0	++0	+--	+-0	+--	+-0	+-0	+-0	++0	+-0	+-0
25	+--	+++	+++	+--	+--	+--	+--	+--	+--	+++	+--	+--

(23)

The intersection of two sets of scenarios S (21, 23) is surprisingly represented just by the steady state, see 15 (21) and 13 (23). It means that a modest modification (22) of the model (19) generated absolutely different set of scenarios. In other words, the models (19, 22) are qualitatively very sensitive.

There are four qualitative different set of variables V, see (23)

V_1	RE RL OP RI RA SR VA	
V_2	NO FR SU	(24)
V_3	IM	
V_4	RP	

For example, the columns RE and RL in (23) are the same. The variables RE and RL are qualitative indistinguishable. The 12 dimensional model (22) can be replaced by four dimensional model. The variables (18) must be just replaced by the variables V (24).

The scenario No. 10 (23):

	RE	NO	FR	RP	RL	IM	OP	RI	RA	SU	SR	VA	(25)
10	++0	+-0	+-0	++-	++0	++-	++0	++0	++0	+-0	++0	++0	

has just two nonlinear variables: RP and IM; their triplet is (+ + -). The following variables are increasing linearly (+ + 0), (25):

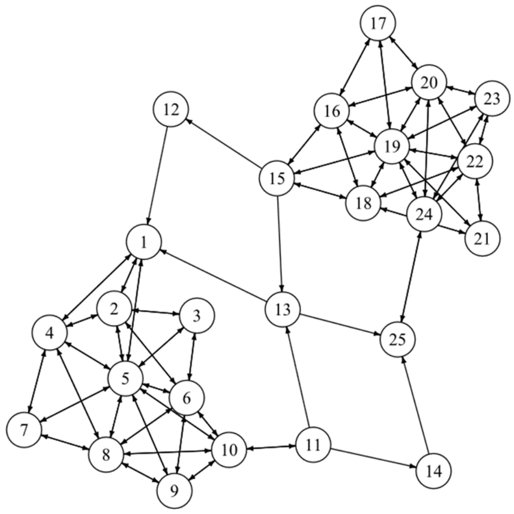
RE RL OP RI RA SR VA (26)

The following variables, see (17), are decreasing linearly (+ - 0):

NO FR SU (27)

The transitions T (17) among the set of scenarios (23) is represented by the transitional graph (see Figure 4).

Figure 4. Transitional graph G based on the set of scenarios (23).



Source: Own elaboration.

A simple visual analysis of the transitional graphs indicates that there are no isolated scenarios. The scenarios Nos. 12 and 14 have one input and one output.

The scenario 13 (23) is the steady state; all its derivatives are zeros (+ 0 0). Let us suppose that the current scenario is the scenario No. 13 and the goal scenario, chosen by a SS researcher, is the scenario No. 10. It is a (semi) subjective choice of SS experts to target the scenario No. 10. There are many paths leading from 13 → 10. The first transition must be 13 → 1, see Fig. 4. A possible path leading from the scenario No. 1 to the scenario No. 10 is:

	RE	NO	FR	RP	RL	IM	OP	RI	RA	SU	SR	VA	
1	+++	+--	+--	+++	+++	+++	+++	+++	+++	+--	+++	+++	
5	+++	+--	+--	++0	+++	++0	+++	+++	+++	+--	+++	+++	(28)
10	++0	+-0	+-0	++-	++0	++-	++0	++0	++0	+-0	++0	++0	

There are several possible interpretations of sets of scenarios. It depends on different interpretations of the variables (18). Some variables can be under a control of a decision maker. The rest of variables is outside the control and represents lotteries controlled by stochastic mechanisms. Many different (partially) subjective interpretations of the types of variables (18) are possible. For example:

Decision variables	δ	OP, VA	(29)
Lottery variables	λ	RE, NO, FR, RP, RL, IM, RI, RA, SU, SR	

Two variables, RP and IM, must be changed to transfer the scenario No. 1 to the scenario No. 5, see (28). It means that this transition depends exclusively on lotteries, see (29). The transition 5 → 10, see (28), is partially controlled by the following one-dimensional transitions:

OP (+++) → (++0)
VA (+++) → (++0)

6. Conclusion.

At present, most of the techniques employed for various SS problems are of statistical nature. The formal tools do not always contribute as much as expected towards a full understanding of the SS tasks. It is no paradox that less information-intensive methods of SS analysis often give more realistic / applicable results.

There are three main advantages of the qualitative SS studies:

- No numerical / fuzzy / rough/ verbal quantifiers are needed.
- It is possible to develop multidimensional SS based on vague heuristics.
- No SS feature can be missed if the analysis is based on a good qualitative model.

The most significant disadvantage is that the SS results are just qualitative. However, if the obvious total absence of deep knowledge SS items is taken into consideration then SS tasks analysis based on qualitative trends represents a significant progress. Moreover, development of qualitative SS models is based on common sense reasoning and expert knowledge only.

A SS user requires transparent and easy to understand explanations why different algorithms generate some scenarios. If formal tools are mathematically too demanding then it is very difficult to introduce them into the SS community. Qualitative SS models are difficult to solve but easy to interpret and understand.

Assessments of SS tasks are often decision-making problems requiring multi-criteria decision-making methods taking into account the conflicting objectives underlying different aspects of SSs.

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