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NUMERIC REPRESENTATIONS FOR MANAGEMENT SCIENCE PROBLEMS

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Management is understanding as a set of executable decisions related to the future supported by a model of the future event based on the owned present information and knowledge. Such simulation is always made during computer aided processes of decision making in uncertainty. It causes that there do exist necessarity of transformation of some nonmathematical aspects of management onto a formal language of computers. It induces a problem of building of numeric representations of mainly semantic models of the management science problems for which it is possible to design suitable algorithms of the syntactic model level. It is very important question difficult to realize especially on the social science level of the management. In addition, the management science didn't response onto Semantic Web concept. This paper try to show that there exist not enough satisfactionary described field of knowledge devoted to relations between models of organization management and information technologies.

1. Introduction

The most aspects of the management science are typical nonmatematical problems. Management science consists of a large number of topics from strictly mathematical, e.g operational research[1], via theory of decision making[21] to humanistic problems, e.g. organization culture[15] or knowledge management[20]. The most of problems derived mainly from so called social and humanistic approach are not related to any semantic model what causes impossible to create suitable numerical representations. From that reason, computer aided functional models in the mentioned cases do not exist. It was shown that using the selective demarcation procedure[11], one of possible criterion of existing of the numerical representation of a given management problem is existence of any measure or minimum principle in the structure of the analyzed problem[9]. It causes that using a defined taxonomy procedure it is possible to extract from the problems of the management science only those, having measure, leaving the rest behind a demarcation line until suitable measure will be find or minimum principle be set[11]. If the measure is defined or minimum principle is find the problems may be subjects of the informatics and computer science applications into management science.

Management science is deeply unordered in epistemological sense[25]. But in relation to the term "management" it is possible to point some spectacular facts which are very important from the computational methods in management science point of view.

1. The management is related to a given system, process, internal and/or external relations (topology of resource set of organization, interactions micro-macro). It means that understanding of the term management should not be restricted to the organization and the internal observer. It legitimizes an epistemological division, where one of the most important, rational criterion of demarcation is the existing of some numeric representations.
2. The main tool of each management process is an executable decision. Each act or process of the management is related to nearer or further future. There doesn't exist management process of past events. Decisions require information aid and may be bounded in relation to a rationality[22]. There exist a group of decisions, e.g. tax decisions, which must be absolute measurable and rationally make[10].
3. There doesn't exist a management process where no information is transferred on any way or no processing of an information is derived. If so, there must exist any symbolic representation describing the state of the managed system before and after decision making. It may be concluded that the numeric representation may exist due to necessarity of the information transfer in the managed system.

4. A results of the management process are always evaluable axiologically and may be also measurable in any way. Each organization or process is evaluated axiologically (good or bad category). But rational and objective evaluation is based on a set of measurable variables as: financial score, level of the objective function realization, etc. At the end all management processes of the organization are resulting tax declarations as an real measurable score. From that reason it should be concluded about the existence of the numerical representation (or set of representations) allowing on tax calculations.
5. The management is based on rational behaviour of the manager system using any minimum principle. It is obvious and derived from the general rules of the nature and economic behaviour. Rationality of decision making may be bounded, but it is related more to changes of the measure base from utility to a level of satisfaction, preserving this way the rules of formal description instead of rejection the existence of the numeric representation of the measure[13].
6. The management results creation of the optimized and stable structures of organization along the time. It is one of the main goals of organizations – time surviving. The most prospective explanation of this problem is resource based view. A set of resources is optimized permanently during the processes of management remaining in equilibrium with the surroundings[13]. From the above it follows the existence of numeric representation for processes of reorganizations and reconfigurations of the resources (e.g. resource evidence, document circuit, etc.).

The presented above principles are universal and may be related to the management of organization, supply chain, process, etc. If one can imagine that for rational management some metaknowlegde supporting decision making is necessary, the problem of conversion question to a computer language and building acceptable interpretations for the received answers derives. In this point the question of numeric representations for pragmatic aspects of management and mathematical modeling of processes of an organization functioning is arising. Thus it is possible to form clear and rational demarcation line between the management transferrable onto formal language, and the rest, not adequate for a category of measurable questions[11,13].

2. The numeric representation of management problem

The numeric representation of any management problem is always a semantic-syntactic model and it is easy to see that for a given functional or ontological model usually exists a set of syntactic models with identical value and interpretation of the numeric results. It is possible to say about the syntactic isomorphisms of a given semantic model and prove that there exists the optimum one[12]. In more formal approach it may be stated that: as the numerical representation of a given management problem one should undestand any morphism of the countable elements of the set of resources onto set of its properties forming a vector space. This way conversion of the ontological model onto semantic level, joined with the vector space formalism, always warranties the existence of a measure (length of the vector of space). The other aspect of the problem remains the definition of a definition range. The best normalization of measurable properties seems to be the [0,1] range (percentage of fulfilling of the given property). Building of multidimensional normalized to 1 vector of properties allows on very clear interpretation of a distance between vectors and precise definition of the measure, even by comparison of representations with different dimensions.

The following problem derives: does the numeric representation of a given problem of management always exist? If not, what conditions must be met for its existing? It was shown, that if a given problem of a management scope expresses a property of having measure, and/or is related to any minimum principle, then do exist its numeric representation[9,13]. It is good condition, easy to apply.

The numeric representation is related both to the state of micro and macro management. In the micro state the best exemplification of this problem is shown in the operational researches, where the basic common element is a measurement. In macro management the numeric representations are fundamental economic models, e.g. general equilibrium of Debreu[7], theory of value[6], ADM model[2] and Nash equilibrium[19]. Assuming the importance of formation and analysis of numeric representations in the management science it is possible to deduce the direction of development and research scopes of this science:

- formal structure description of organization,
- micro and macro state description in the management,
- relations micro-macro interactions,
- time transformations of the representations,
- goals or objective function representations.

Resolving of the above problems will allow on a big step into building information systems aiding management of Sementic Web (Web 3.0) level[5]. It is automatically fulfilling a big hole in relations between

the management science and informatics, derived from problematic definitions of the management processes in a semantic model form. It is obvious that the presented above set of aspects is only a small part of problems to resolve. Nevertheless it shows important ways of research of the applications of informatics in the management science.

2.1. Formal representation of the organization structure

The structure of an organization in a formal description is the best presented in the resorce based view[11,13]. It defines pure imagines of the objectives for which a numeric representation if formulated. The organization as a set of resources may be defined formally as follows[13],

Let there be a given composite entity (structure) **S** = [**U**,*O*,*R*] determined on economic objects U, called an organisation, consisting of:

i. non-empty set **U** of objects called Resource **S**
ii. indexed set O of operations allowed on set U
iii. non-empty, indexed set R of possible relations on set U,

then:

1. Set S is an economic organisation in the resource approach with the defined state of resources at a given moment.
2. Management is defined as any process of change of the state of resources from A to a different state B, using allowed operations and relations.
3. If operating on elements that are isomorphic representations of the defined objects, relations or operations of structure S, some true observation sentences are derived,

then the isomorphic set is a model of organisation S.

This way very precise numeric representation of an organization was introduced. It may be noticed that for the resource based view suitable symbolic representation always exist, e.g. document circuit, value of resources, usability of resources, etc.

3. The representation of micro and macro state

Assuming that any macro state of economic system is a Cartesian sum of all micro states on a given area (set of all organizations on a given area), then the set of all structures describing an organization in a given context may be understand as a formal representation of the macro state. It is the simplest form of a macro state definition, remaining similar definitions of the great sum of states in statistical thermodynamics. There are no reasons to reject such approach to economic interactions of an organization with the surroundings. But the numerical representation in a form of the sum of states is rather useless. It is necessary to find suitable averaging procedures, resulting some easy for interpretation and countable perimeters of the macro state as welfare level, per capita income, economic pressure, etc.[18]. This way of reasoning is adapted from the statistical thermodynamics as an analogy to some economic systems[8]. Such works are existing in the literature and they allow on good quantitative estimations of some average interactions on a given area[16], but there is a lot of open discussions about possibilities of using formal and mathematical approach into social sciences[17]. But because operational research and the related methods have achieved spectacular results, regardless critical remarks of some “social oriented” authors. This is the border of the selecting demarcation in the management science[13].

3.1. The numeric representation of micro-macro interaction

The organization tends to optimum state modifying functionality of its resources on the way of managing what led indirect to maximization or minimization of the objective function. It may be assumed that the usability of the resources is a payoff function of two-persons game in the von Neumann sense between the organization and the surroundings, yielding at the end the equilibrium state in Nash sense. The optimum in the Nash sense state means the best management strategy and therefore the maximum functionality level of the organization resources (micro state) in a given macro surroundings[12].

A good example of the organization interactions with the surroundings may be based on the game theory formalism[24]. Let us define the formal definition of the game as follows:

1. There are two players: the managed system (player 1) and the economic surroundings (player 2).

2. Strategy of player 1 is based on assumption of some perimeters (e.g. numbers of the different resources, necessary for running organizational processes) in such way, that the capital exchange with the surrounding is maximum.
3. Strategy of player 2 is based on the choice of such values of the available external perimeters influencing organizational processe (e.g. income per capita, exchange rate, market price, economic volume, etc.), that the exchange of capital between the organization and the surroundings will achieve minimum.
4. The game is started with the managed process.
5. The payoff in this game is equal to the exchanged value of capital between the managed system, and the economic surroundings.

The game is matrix a zero-sum type in the case of the equilibrium state, and a non-zero sum one in other cases, when some self running processes appear in the analyzed economic system. It is possible to notice, that the above model of the game is very clear and simple. The most of the economic processes may be subjected to the above defined constrains without loosing the generality. In consequence the presented formal approach offers all benefits derived from the von Neumann theorem[24].

As consequence of the defined above representation is not only warranty of the existing of the numeric representation of a given interaction, but also the optimum strategies of both players. Further there do exist in the game an equilibrium state in Nash sense what means the existing of optimum management way[12]. The game theory approach into interactions between the organization and the surroundings is not the only possible. It seems to be the most universal. Therefore designing numeric representations in this view may offer the best results, especially those related to the Nash theorem.

3.2. The representation of micro state changes along the time

In the resource based view, an organization is a countable set of its resources. Each element is related to itself symbolic representation or numeric representation, e.g. value of the resource, its quantity or usability and other, possible categories, measured direct on indirect. Such set is not stochastic, but it is ordered what is always related to its topology and derived from some topological properties. The representation of changes the organization along the time may be defined by all topological and measurable (valuable) properties of the resources. Such changes causes an influence on a functionality of the resources and in consequence, on the total utility of the whole organization at a given moment of time. On the figure 1, an example of the management model is presented, regarding a game theory approach and minimum principle applying[10].

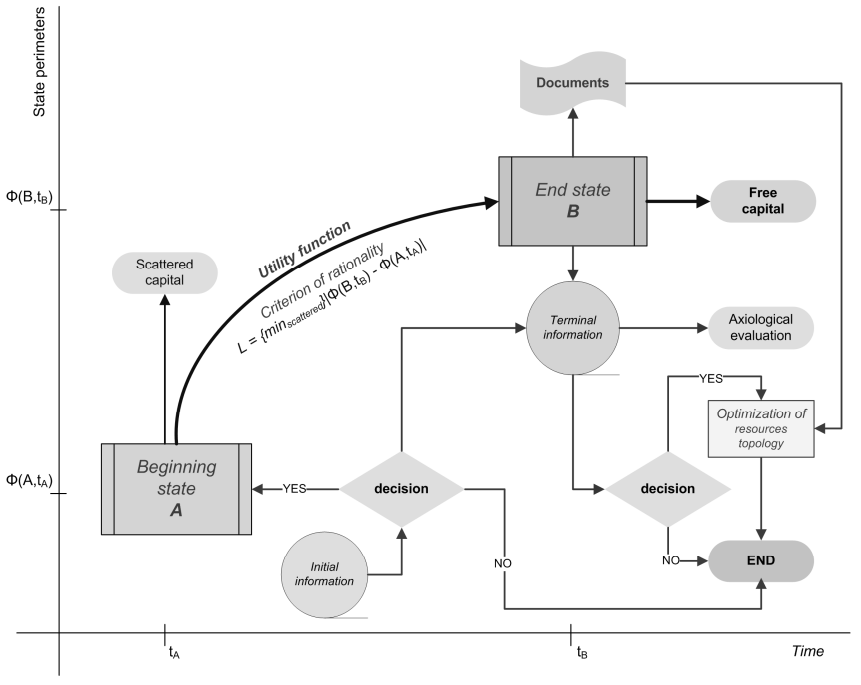

Figure 1 Illustration of the resource based model of the management along time [source: self elaboration]

Managing of a resource system during some time may be understand as a logical set of events and results derived from the decisions taken(figure 1).

1. It forces transformation of the set from the state A to a different from A state B.
2. It is restricted to a time limit range $[t_A, t_B]$.
3. It requires processing or exchange some information.
4. It uses defined objective function or any representation of the minimum principle.
5. It leads to taking of some decisions.
6. It results some capital flow and scattering.
7. It changes the state of resources.
8. It generates suitable documents circuit.
9. It induces optimization of the organization topology.

Determination of the state using usability or functionality of the organization's resources at a given moment is resulting good numerical representations and axiological measurements of managing. These representations are explaining topology of resources, and allowing on estimation of its changes.

4. Numerical representation of the objective

It is one of important aspects of the operational research, linear programming, game theory methods, muliticriteria analysis, supporting the process of decision making under uncertainty. Its special importance is based on ability of setting a measure method of management results and designing a semantic model of a given problem. The objective function is always the best numerical representation. But in the case of organization management the objective function is always very difficult to set univocally and not dependent on time. Practically the objective function is modified by a manager regarding to internal situation of the organization or as an answer on changes in the surroundings. It is strongly related to utilization of arising occasions or catastrophic changes in the surroundings. The objective function is permanently changing in elastic way[6,13].

4.1. The numeric representation of forecasting

This aspect of numerical representations of management science problems is related to strategic management. The best example of numeric modeling of future events in business is the Bellman's equation (dynamic programming equation) for time series[3]. The method is used to solve problems in economic theory including optimal economic growth, resource extraction, principal-agent problems, public finance, business investment, asset pricing, factor supply, and industrial organization[23]. Also scenario approach as a model of organization behaviour or its economic activity forecasting (e.g. optimization of order wallet) may be modeling with binominal trees[14], what generates exact numeric representation. Is some cases of probability type processes (where results may be related to Wiener processes) good numerical representation may be received from simulation Monte Carlo[4]. All the mentioned above semantic models may be converted onto set of syntactic isomorphisms in symbolic, computer syntax.

4.2. An example of the numeric representation

As a one of the most important examples of numeric representations of management problems a measure problem of an event evaluated in non measurable categories is valuable for presentation. As examples of non measurable direct categories functionality, usability, level of satisfaction, rationality may be pointed. These categories are evaluated subjectively, and they are changing by managers depending on the changes in the surroundings. An additional complication for comparisons is deactualization of some previously important evaluation components of a vector space base of the representation, and possibility of arising the other. It causes changes of dimensions of a vector space of the representation and it is necessary to apply renormalization of the resulting vector after the transformation what allows onto expressing of new vector norm and compare lengths of the vectors for different dimensions vector spaces. One of applicable solutions is normalization to unity (100% scale). It is acceptable measure easy to physical interpretation and practical realization. It should be noticed that changes of the measure definition along time is one of elements of management. The importance of components of the measure vector and the objective function of an organization is changing in time due to manager acting and the surroundings influence. Hence the same time the representation of the measure is changing respectively.

Let be given a set of characteristics of a given resource $C=\{c_1, c_2, \ldots c_n\}$ representing utility of the resource. It means that **C** is a formal representation of the given resource. A vector of utility measure **U** is defined as any linear combination of the component vectors $\mathbf{c}_i$. $\mathbf{U} = \Sigma\alpha_j\mathbf{c}_j$; where α_i are coefficients of importance of the representing property in a general measure (e.g. statistical weights in subjective evaluation). As it was

mentioned each vector representing a given property component c_i is defined in a range [0,1] (percentage level of satisfaction fulfilment for a given component related to 100%). Thus $c_i = \beta_i \mathbf{e}_i$ where $\mathbf{e}_i$ is a unitarny base vector representing appropriate utility component, and β_i is a normalization coefficient. It is obvious that for the ortonormalization purposed the following relation must be satisfied $\forall_{i,j}\ \mathbf{e}_i\mathbf{e}_j = \delta_{ij}$ (Cronecker delta function). This way the vector **U** renormalized to unity requires of fulfilments the following statement $\sqrt{\Sigma\alpha_i^2\beta_i^2} = 1$. Thus the univocally utility representation is created based on the vector space formalisms. The following properties of the formed representation may be pointed:

- it allows onto comparison between representations with different vector base dimensions,
- addition or removing from the vector space base any component has no influence onto total measure construction,
- the utility of resource vector in the metric space is always normalized to unity (is ranged from 0 to 1).

Based on representations of real problems the managing is based on changes of some properties of the resources. It the first step all evaluations of the level of satisfaction achievement of a given component tends to 100% (it means increasing of β coefficient). The external bounds and evaluations of the interactions between the organization and the surroundings allow on modifications of α coefficients. This way a good numeric representation with wide spectrum of possible applications in the management science is created. It is based on relational evaluations (not absolute measurements) but it is satisfactionary level of certainty for managing decision making. So it is interesting aspect for applications of the informatics in the management science problems.

There exists possibility to apply some chances of the utility vector along time for defining a managing process. In the representative management view it may be understand as a linear transformation operator in the metric space vector, where the base of the vector space is formed from the representations of choosen properties of the resources. From this point the formalism of the linear vector spaces with metric (e.g. Banach spaces) may be applied, what would extremely extend possibilities of the managing processes quantification.

5. Conclusions

Some important aspects of numerical representations of some problems of the management science shown in this paper are important for the development of computational methods and informatics applications in management. The epistemologically ordering aspect of numeric representations in the management science is very attractive from the management theory point of view. Some models of formal representations presented in this papers are universal and leading to creation of good defined morphisms of semantic models into syntax level. The use of numeric representations is strong support for a resource based view of the organization and allows on successful quantification of some problems of the management science. Therefore forming of the numeric representations seems to be one of the most important direction of the development of applicable informatics. It is also the good answer onto concept of Semantic Web into management supported by computational methods.

It should be taken into account, that for any conversion of a management problem to its numerical representation, the appropriate measure and scale must be defined. Also it is necessary to evaluate possible ceteris paribus influence on the obtained results. Because management is a specific conglomerate of interdisciplinary aspects, there is no precise global information about possible simplifications. Therefore semantic modelling of uncertain events are only more or less estimations of the problem and in practice, managers are using less detailed information support. But semantic web concept forces formation of new avenues toward good numeric models of non-mathematical problems.

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