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HEURISTIC ANALYSIS – ANALYSIS FOR HEURISTIC MODEL CREATION

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Abstract:
Synthesis, design of a new logistics system, changes the existing system after analysis of the production, marketing, distribution, service systems and their management. The most often analysis applied is systems analysis, SWOT analysis, statistical analysis, multi-criteria analysis. Each analysis has a different objective, the reasons for the application, complexity, and methodology. The modelling of decision-making activities is essential for a model creation – a synthesis of a logistic system, which is mostly applied in a heuristic approach, based on modelling solutions and processes that human experts use for their activities. This article describes the specific methodology of analysis – analysis for heuristics models design.

Key words: *heuristics, modelling, analysis, synthesis*

1 INTRODUCTION

Creation of a heuristic model as the base for a synthesis requires a precise analysis. Due to the fact that heuristics is defined as a method for mental activities modeling carried out by human beings, the biggest amount of synthesis applications is in the management processes. [1], [3], [11]

Particularly in logistics/LS/, it is mostly in processes of [3], [6], [5]:

- forecasting,
- operative planning,
- production scheduling,
- supplier selection,
- design of distribution network structure, etc.

This means, that it is mostly used as the essence of these activities or in a process of decision.

Heuristic analysis should create an outlet for heuristic model synthesis. An outlet for decision is a collection – database of information and rules. When there is the input information for such decision process (e.g. historical basis of data about product sales), by

executing analysis, then it is able to describe algorithms, sequences of steps and rules as executed by a human being during decision making [6] [7].

An analysis for heuristic model creation and LS synthesis according such model is executed to existing systems, respectively to analogical – gauged system. This method is suited for innovation projects, where productivity and process efficiency by automation and informative control activities need to be improved. This improvement is carried out by a system optimization (with applied principles of optimization during heuristic model creation), and flexibility increase.

2 THEORETICAL BASIS OF HEURISTIC ANALYSIS

Heuristic analysis comprises principles of:

1) Theory of elementary information processes – system / process is breakdown into such small processes that could be modeled and solved. Solving problems is transformed into a decision tree [1], [2], [8].

$$S(t,\alpha(t)) \rightarrow R_1 \rightarrow S_1(t_1,\alpha(t_1)) \begin{cases} \rightarrow R_{11} \rightarrow S_{11}(t_{11},\alpha(t_{11})) \\ \rightarrow R_{12} \rightarrow S_{12}(t_{12},\alpha(t_{12})) \end{cases} \quad (1)$$
$$\rightarrow R_2 \rightarrow S_2(t_2,\alpha(t_2))$$
$$\vdots$$
$$\rightarrow R_n \rightarrow Sn(tn,\alpha(tn))$$

Fig.1 *Display solutions in the form of decision tree*

2) Decision tree breakdown into triads and cascades.

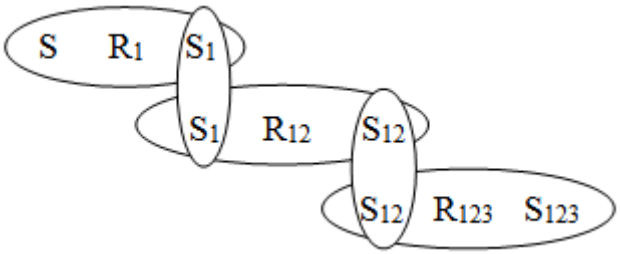

Fig.2 *Disintegration solutions to decision-triads and cascades*

The solution implemented by elementary triads Si Ri Si+1. Output of triads Si+1 is input to the next triad.

3) As seen from 1), to be able to analyze a problem, it is necessary to know:

-the set of rules ... $\bar{R}_i$, ... $\bar{R}_{ij}$
-the set of following situations ... $\bar{S}_i$, ... $\bar{S}_{ij}$

To perform an analysis - it means to create a defined structure (1), more precisely define situations and rules.

4) For the structure definition (1), it is sufficient to know the initial situation S (t, α (t)). (Situation S in time t, with features, parameters α(t)) and set of rules $\bar{R}_i$.

5) Definition of heuristics

Analogy – induction

Decision rules $\bar{R}$ bring to heuristic models experiences, praxis, intuition because these are expressed in concrete techniques, steps, decisions, situation reactions, etc. that is why the analysis of rule definition initiates from:

- Knowing how people do it,
- Why they do it,
- What rules they apply for particular activity.
- By the L.D. Fogel [2] are define three type of the decision making processes.

When:

- X_i– inputs information to the decision making process
- R–resut of decision-solution
- Y_i-output of the decision making

Than:

- deductive decision making process

$$Yi = R(Xi),$$

- abductive decision, based on the use of previous attempts, i.e. if, for example between inputs Xi and outputs Yi is detected relationship (R rule), then the most likely cause of a new effect Xj. Yj is a prerequisite; then we can write:

$$Xj = R^{-1} (Yj).$$

Inductive decision constitutes an inductive process of finding the most likely patterns (rules R) based on the known input information and anticipated solutions Xi, Yi.

$$R = f (x, y)$$

Inductive decision making is closest to the creative activity of man. It should be stressed that the operator / decision / - R is not unique. Deductive decision making is exact (analytical) deciding abductive decision is on the border and belongs to the precision and heuristics in decision-making are inductive and heuristic.

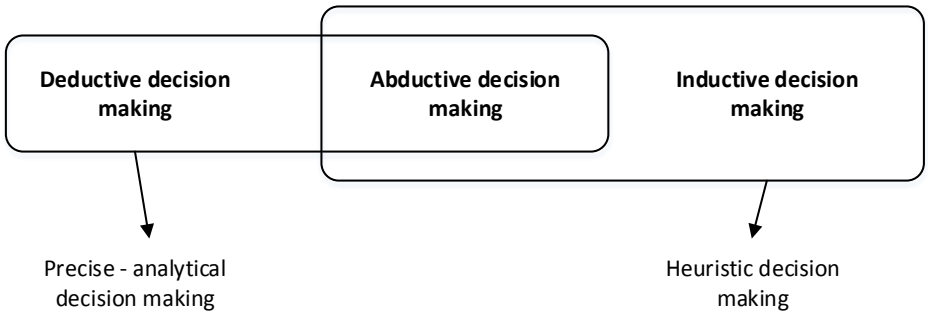

Fig.3 *Types of decision-making processes [2]*

Execution of repeated activity (during model preparation) and fact that practice has verified correctness and success of it means achieving a suitable tool for future control.
These conclusions based on repeated analogy and abductive and inductive decision making.
If particular rule R_i is valid for situation S_1, S_2 ... S_n and provided suitable solution y_i. then if situation S_{n+1} is analogical to situations S_1, S_2 ... S_n , rule R_i is also suitable for its solution.

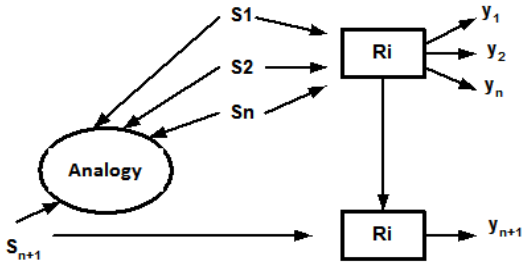

Fig.4 *The Induction principle [4]*

Heuristic rules are created by induction according to repeated analogy. It is difficult to divide the phase of analysis from synthesis especially in case of heuristic approach. This is a model approach and it has its own specifications [6], [9], [11].

6) Definition of further rules[3], [8]

Several other rules need to be defined besides the group of heuristics $\bar{H}$:
TP - technological rule, are rules are defined by technological regularity, e.g. duration of (slab) movement in (pusher furnace) cannot exceed 120 minutes, if it is loaded as a cold, because its inner material structure would be destroyed.

- Slabs on the rolling mill are rolled from the widest to the narrowest due to cylinder wearing.

Ō - constraints, rolling temperature of slabs at the entry to the rolling path cannot be less than 1200ºC.
Ē - expert rules, defined particular activities decided to keep in charge of a person - planners, logistic manager, dispatcher because:

a) These activities are not suitable for modeling – and for automation,

b) When they are not needed to model them due to "user friendly" purposes and person's participation is requested.

KO – optimization criteria. Innovation, re-engineering of LS has a defined goal implicitly and explicitly – process of system optimization as an entity. LS optimization always leads to a multi-criterion problem. In analysis, it has to be defined main optimization criterion. In synthesis it is necessary to set up the target as followed:

- maximize machine capacity utilization,
- minimize energy consumption,
- determine the order – sequence of product manufacturing,
- optimize production progression from chemical consistence point of view, dimensions ,etc.
- optimize smoothness of parameter changes,
- minimize distribution path.

The main criterion is always the criterion of consumption because each of the above-mentioned criteria is directly or indirectly transferred into expenses.

By analysis, there can be defined rules, formulas and algorithms for calculation of these criteria and their relations either mathematically, logically or informationally.

From the practical point of view, analysis is performed by any possible means, such as internet, company documents, theory, research but mostly by a detail exploration of people, their intellectual activity during decision making and managing, by algorithms, verbal description.

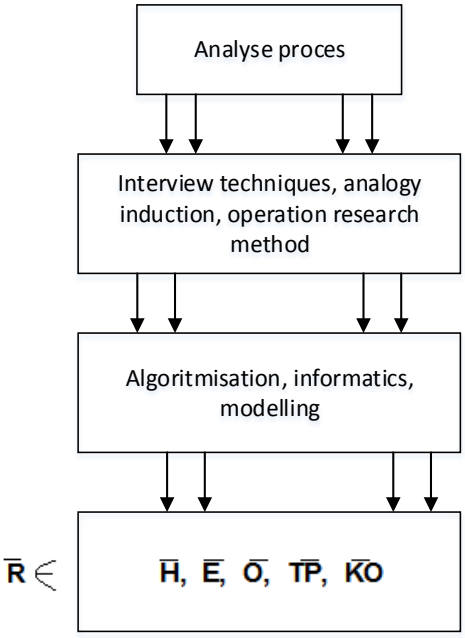

Fig.5 *Principle of rule definition*

The result of the analysis for the creation of a heuristic model is a set of rules, constraints and criteria optimization of R (H, E, O, TP, KO, HKO), which proposed a heuristic model must be respected and through which empirical knowledge, experience, intuition - human intelligence is transferred to the model. For synthesis it is necessary to define the order of application of these rules in the model. Vector R rules, obtained by the

analysis shall be supported through artificial intelligence-informatics, statistics, operational analysis, design methods. Their synergy gives a possibility to create models for unsolved mathematical problems, with a higher quality than performed by a man.

3 CONCLUSIONS

Automation of decision problems in logistics, is often the only possible way to create models that are similar work of a real practical man (a logistic operator, an expert). It is necessary to carry out a specific analysis different from other types of analysis, such as SWOT, system analysis, multi-criteria analysis etc. for the synthesis of this type of model – the heuristic model. The methodology of this analysis, the necessary results, (a set of rules R and the sequence of their application in the model) are described in this article, based on the application of dozens of models of real solutions to the projects in the field of operational planning and scheduling especially in manufacturing companies.

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