Logistics & Production

Modelling of modern enterprises logistics

Marek Fertsch, Katarzyna Grzybowska,
Agnieszka Stachowiak
(eds.)

MONOGRAPH

Publishing House
of Poznan University of Technology

Poznań 2009

Reviewers:
Prof. Tomasz Nowakowski, Ph.D. Eng.
Prof. Radosław Pytlak Ph.D. Eng.

Cover design, typesetting:
Marek Derbich

ISBN: 83-7143-856-1

Edition based on ready to print materials submitted by authors

Publishing House of Poznan University of Technology
pl. M. Skłodowskiej-Curie 2, 60-965 Poznań, Poland
tel. +48 (0) 61 665 3516, faks +48 (0) 61 665 3583
e-mail: office_ed@put.poznan.pl
www.ed.put.poznan.pl

Orders should be sent to:
Księgarnia Politechnik
ul. Piotrowo 3, 61-135 Poznań, Poland
tel. +48 (0) 61 665 2324, faks +48 (0) 61 665 2326
e-mail: politechnik@politechnik.poznan.pl
www.politechnik.poznan.pl

Printed by: Prymasowskie Wydawnictwo Gaudentinum – Drukarnia Cyfrowa
ul. Jana Łaskiego 11, 62-200 Gniezno
www.gaudentinum.pl

Chapter X

THE MODEL OF LOGISTICS PROCESSES' RISK MANAGEMENT

Ewa KULIŃSKA*

1. INTRODUCTION

This publication presents possibilities of the application of the principle of V.A. Gorbatova specification for the purpose of solving practical issues in the scope of logistics processes modelling.

One of main assumption of logistics processes operation facilitating the implementation of objectives and influencing on adding values is the safety of operation. This safety is understood as efficient risk management of the process.

The management consist in modelling, arrangement, composition of complex process in cause and effect line of logical structure facilitating the implementation of objectives, delivery of products of as good added value as it is possible taken over from the clients and company point of view.

Each process characterizes by the fact that a set of logically connected statements or actions are carried out to achieve some result. The replacement of Input and Output characteristics is determined by a structure and operation. The structure provide expected functioning of examined process, however the process operate adequately to as structure. Search of structural and operation connections of processes and optimal logical structures form main assumption of specification principle.

2. ESSENCE OF CHARACTERIZATION PRINCIPLE

The principle of characterization consists in mutual interpretation of operation model ψ_a of examined object (asset) with a model of its structure ψ_b. Obtaining a result that is establishing mutual influence of structures is obtained by the selection of principles, rules of proper operation expressed by a model ψ_a.

---

* Opole University of Technology

The supremacy of characterization over familiar models of linear and dynamic programming and others which for the purpose of finding optimal variant of a solutions implicate the necessity of generation and assessment of a set of all solutions are manifested in the analysis of defined features of solutions without the need of its subject generation. System interpretation of tasks in accordance with the principle switches first of all to the following [5]:

1. determining (seeking) not only the solutions but also characteristic features;
2. characteristics of solutions should be referred to representatives (invariants) of classes of equivalent solutions;
3. class of equivalent solutions is formed as a result of Input data interpretation of solved group of statements in categories of solutions' features.

Classes of equivalent solutions occur usually in less amount than solely solutions and the analysis of solutions' features can be conducted without its direct (said issue) generation. The studies which are formal and are verified considering methodological matter on given scope of characterization principle construct the theory of characterization. Its essence contains in mutual interpretation possibilities of a model of operation of examined object with a model of its structure. Mutual interpretation possibilities of models are obtained by the following [5]:

- selection of universal principles „correct operation" (expressed in a model of operation),
- structural interpretation of operation model.

Universal principles „proper operation" are expressed by so called graph figures described as [13]:

- mandatory – abstract construction which in a form of homeomorphism should occur in a model of operation „subject to" its error;
- forbidden – easily identifiable objects which isolation or split (in a model of operation) gives a guarantee of obtaining a correctness of object operation;
- neutral – are intended for performing transformations simplifying a model of operation and as a result the forbidden figures and mandatory figures are not formed.

The object shall operate correctly if mutually unique interpretation among rules of its operation can be defined and prove mutual unique interpretation between rules of operation (described with operation model ψ_a) and implementing structure (described with structure model ψ_b) [13]. For the purpose of determination and prove unique interpretation of these two models the following assumptions are taken:

- resources operate adequately to its structure,
- structure of the resources is adequately to its expected method of operation.

The essence of characterization rules can be described in a general outline [5]:

$$< \psi_a, \psi_b, P_0(\psi_a, \psi_b) > \quad (10.1)$$

where:

ψ_a – model of operation,

ψ_b – model of a structure,

$P_0(\psi_a, \psi_b)$ is an atomic predicate which characterizes the possibility of the interpretation of a model of operation ψ_a in categories of structure model ψ_b.

Practical application of characterization rule for the purpose of solving determined group of tasks (problems) require the preparation of adequate theory expressed in detailed determination of models ψ_a, ψ_b and a predicate P_0 [13].

3. THE APPLICATION OF CHARACTERIZATION PRINCIPLE

For the purpose of conducting researches and planning experiments data obtained in the years 2003 - 2008 in two groups of companies will be applied. First group contains organizations which deal with risk management; second group includes organizations where risk control is not applied. Researches focused on finding common features for each of group separately. The characterization referred to the following:

- meters significant as far as forming and realization of added value for clients are concerned
- meters significant as far as forming and realization of added value for a company are concerned
- meters of logistics processes
- meters applied in risk management.

On this basis a model of assessment unlike mentioned above was prepared, it is suitable only for axiological base of risk management of logistics processes (it is not applied to logistics processes measurement, level of added value neither risk management).

The application of a principle of V.A.Gorbatov characterization used to solving research problem is presented in the diagram – fig. 10.1.

The application of characterization principle in research problem solving consist in a preparation of a theory which as far as axiological bases of logistics processes conception of risk management is considered shall determine in detail the following:

- Models of companies' operation applying integrated system of risk management (ψa) – include rules of operation of these companies in 2003-2008.
- Models of companies structure applying integrated system of risk management as well as companies which do not apply integrated system of risk management (ψb) – models comprising information about common features of these companies in 2003-2008. On the basis of an analysis of both models of a structure a level of formed and implemented added value and actions influencing on it afterwards will be possible to determine.
- Atomic predicate $P_0(\psi_a, \psi_b)$ – determining a possibility of an interpretation of operation model in categories of structure model.

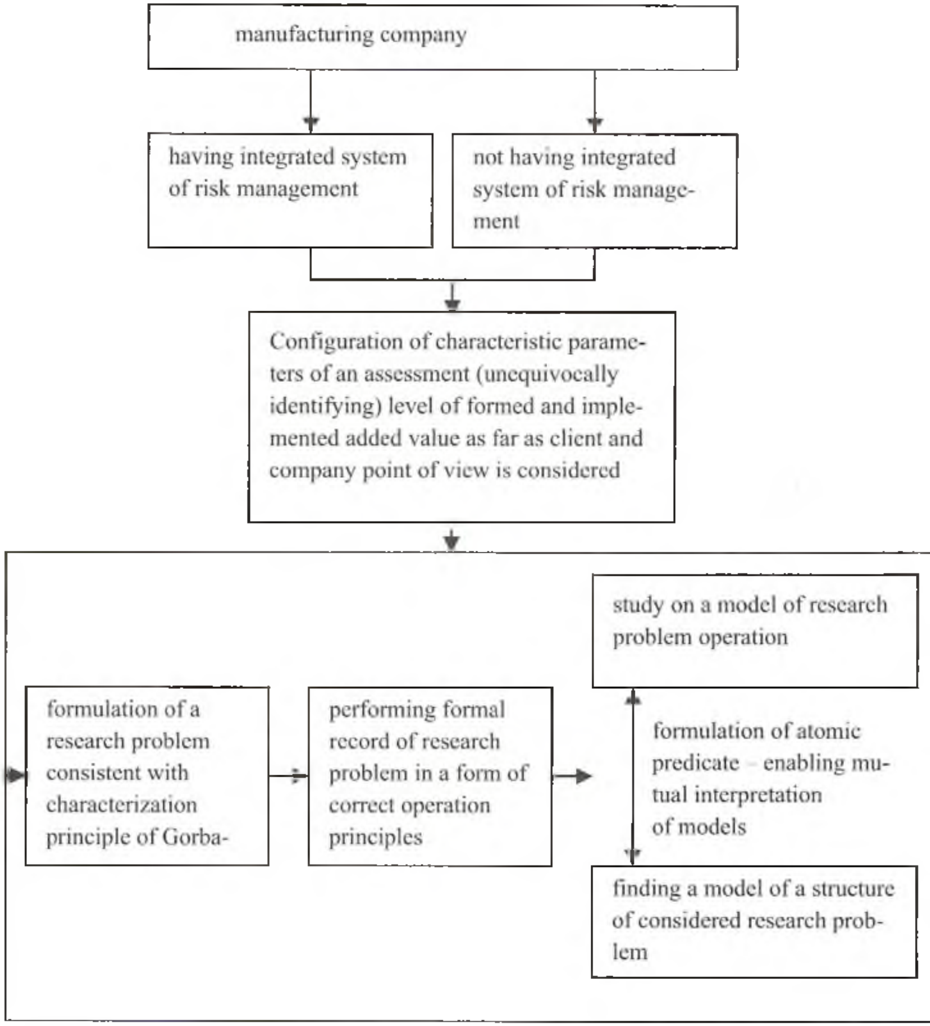

Fig. 10.1. A model of the application of characterization principle of V.A.Gorbatov for the purpose of research problem solving *Source: own study*

A level of formed and implemented added value was described with the aid of adequate meters. A base of construction of operation model and a structure is determination of direction of value change (increase or decrease) of each meter in 2003-2008. Searched solution of research problem is a set of structure models (ψ_b) which for a given case of a company shall determine the following:

- level of formed and implemented added value of logistics processes in companies applying risk managements and in companies which do not deal with risk management;

- influence of risk management on the level of formed and implemented added value on the basis of an analysis and comparison of structure models in both group of companies.

Search of optimal solutions is implemented on the basis of research experiments conducted in the following phases:

1. Construction of a set of logic propositional function for two groups of companies – a function was recorded and expressed in a language of characterization principle the information of a level of formed and implemented added value.
2. Set of graph models of propositional functions for two groups of companies, it is a graph presentation of logic propositional functions. In graph models in logic propositional function occur so called impossible objects which should be cleaved to obtain operation model.
3. Set of operation models for two groups of companies – they represent rules of operation of two groups of companies as far as forming and implementing added value through logistics processes is concerned.
4. Set of structures' models for two groups of companies – models are solutions of formed research problem. On this basis it is possible to assess a level of bankruptcy risk and determining preventive actions.

Changes in economy and finance condition should be written in a language of characterization principle in the following form:

- set of logic propositional functions - first phase brings result in a form of propositional function for each of companies groups;
- graph models of propositional functions – second phase brings result in a form of graph models for each of companies group;
- set of graph models of operation – third phase brings result in a set of graph models of operation for each companies group;
- graph models of a structure – forth phase brings result in a set of graph models of structures for each group of companies. Results of this phase are a solution for research problem.

Formal record of solutions of research problem is the following relation:

$$X = Z \cup R \tag{10.2}$$

where:

X – a set of companies tested in respect of risk management on forming added value of logistics processes X_i.

Z – set of companies using rules of integrated risk management Z_i

R – set of companies which do not use a system of risk management R_i

$$\forall_{X_{i=1}^{n}} \quad X_i \in X \text{, w – all analyzed companies,} \tag{10.3}$$

$$\forall_{Z_{i=1}^{n}} \quad Z_i \in Z \text{, n– amount of companies with implemented system of risk management,} \tag{10.4}$$

$$\forall_{R_{i=1}^{m}} \; R_i \in R$$, m– amount of companies without implemented system of risk management (10.5)

but assuming that $X = Z \cup R$ amounts to $w = m + n$.

The influence of risk management on forming and implementation of added value through logistics processes shall be examined on the basis of prepared measures M.

$$\forall_{M_{i=1}^{p}} \; M_i \in M$$, p - amount of considered measures. (10.6)

The application of rules of characterization principles require taking into account rules of algebra of logic, therefore M variable can assume only value 0 or 1 (falsehood or truth). The application of these rules force correct way of interpretation of analyzed measures.

Therefore:

value 0 – M_i variable takes, as value of measure decreased in time t_{i+1} in comparison with preceding period t_i.

value 1 – M_i variable takes, as value of measure increased in time t_{i+1} in comparison with preceding period t_i.

$$M_i = \{0,1\} \tag{10.7}$$

In such terms, M_i variable shall reflect a direction of changes (increase or decrease) of added value implemented through logistics process. It will be a basis of assessment:

- correctness of integrated system of risk management,
- size of formed and implemented added value trough logistic processes in both types of companies,
- characteristic features for a state of the application of a system of risk management in forming and implementation of added value trough logistics processes,
- characteristic features for a state when a system of integrated risk management is not applied in forming and implementation of added value trough logistics processes,
- verification and quantification of an influence of logistics processes forming added value on designing a system of risk management,
- verification and quantification of an influence of risk management on forming added value through logistics processes,
- preparation of a model of quantification of a change of a level of measures of added value of logistics processes as a tool supporting decision process in risk management of companies.

Taking advantage of rules of reliability theory bases for a generation of group of adequate measures were applied. Assuming that process risk is a sum of unreliability (Z) and reliability (N) of a system of actions composing on the process the equation will be true [1]:

$$R = Z \cup N = 1 \tag{10.8}$$

and

$$R = 1 - N \tag{10.9}$$

The risk of logistics process is influenced by the reliability structure determining the reliability relation of the process with the state of actions reliability included in the composition. Therefore, the analysis must take into consideration a division of a process on individual sub-processes and actions that is components of sub-processes. Decomposition follows to isolate such sequence of actions which characterizes with serial system. In such system a reliability structure of individual actions is its product, hence the more actions in sub-process the less reliability occur. Reliability of logistics sub-process of serial system shall be defined with the following formula:

$$N_{PL} = N_1 N_2 \ldots . N_n \tag{10.10}$$

where:
$N_1 N_2 \ldots . N_n$ – reliability of individual actions (component of a sub-process).

Therefore, total risk of the sub-process shall amount as follows:

$$R_c = 1 - [(1 - R_1)(1 - R_2) \ldots (1 - R_n)] \tag{10.11}$$

where:
R_1, R_2, R_n – risk occurring in individual actions of logistics sub-process.

For n number of component actions of such logistic sub-process the amount of risk can be calculated as follows:

$$Rn = \frac{S_n}{W_{PL} - S_1 - S_2 - \ldots S_{n-1}} \tag{10.12}$$

where:
S_n – means loss in n amount of actions caused by occurrence of risk factor in this domain r_n,
W_{PL} – means analyzed index from determined domain or logistics function [6], [11].

S_n loss in individual actions depend on time loss caused by expansion of duration of logistics process due to risk factor occurrence. Logistics process accomplishes assumed objective, however it requires more time for completion. Loss in objective accomplishment of logistics process caused by risk factor occurrence will be presented as follows [1]:

$$S_n = W_{PL} * \frac{\Delta t_n}{T} \tag{10.13}$$

where:
Δt_n – time loss refer to given action (delay),
T – period determined for objective accomplishment.

Therefore, total risk R_c for logistics process of n actions will amount to the following accordingly [1]:

$$R_c = 1 - [(1 - \frac{\Delta t_1}{T})(1 - \frac{\Delta t_2}{T})...(1 - \frac{\Delta t_n}{T - \Delta t_1 - ... - \Delta t_{n-1}})] \qquad (10.14)$$

Amount of measures for the analysis of axiological dimension of risk management of logistics processes will depend on numbers considered in W_{PL}.

Considering synthetic character of the preparation, a method of model implementation on the basis of exemplary transport process will be presented.

For simplification purposes, to explain a sense of characterization principle, we can assume that a map of risk distribution of examined transport process is a table of bivalent distribution {0,1} where 0 means a risk of little probability of occurrence and little effects, easy to control, of low cost; 1 – high risk of high occurrence probability, extensive effects and the reduction of effects will require great investments; table fields where is a relation between an action and given type of risk are filled with a line.

Table 10.1. Decision table – risk identification for actions (components) of transport process. Source: own study

Actions, process components	RISK TYPE						
	X1	X2	X3	X4	X5	X6	X7
P1	1	1	-	0	-	-	1
P2	-	-	1	-	-	1	-
P3	0	-	1	1	1	-	1
P4	-	1	-	-	0	1	0
P5	0	-	-	0	1	1	-

Presented decision table 1 allows for formulation the following logic sentence describing risk management of transport process [12]:

$$F(P^{\sigma 1}{}_1, P^{\sigma 2}{}_{2,...,} P^{\sigma 5}{}_5) = P_1\overline{P}_3\,\overline{P}_5 \vee P_1P_4 \vee P_2P_3 \vee \overline{P}_1P_3\overline{P}_5 \vee P_3\overline{P}_4P_5 \vee P_2P_4P_5 \vee P_1P_3\overline{P}_4 \qquad (10.15)$$

Modelling consists in finding logic structure ψ_b, with the aid of the above detailed function is implemented. Operation model ψ_a, is specified as the following statement:

$$\psi_a = \langle M,S2,S3 \rangle \qquad (10.16)$$

where:
M – set of propositional variables;
S2 – set of relation defined with 2-elements alternative terms;
S3 – set of relation defined with 3-elements alternative terms.

$$M = \{ P_1\ \overline{P}_1\ P_2\overline{P}_2\ P_3\overline{P}_3P_4\ \overline{P}_4\ P_5\ \overline{P}_5 \} \qquad (10.17)$$

$$S2 = \{ \{ P_1P_4 \}_2 \{ P_2P_3 \}_3 \} \quad (10.18)$$

$$S3 = \{ \{ P_1\overline{P}_3 \overline{P}_5 \}_1 \{\overline{P}_1P_3 \overline{P}_5 \}_4\{P_3 \overline{P}_4P_5 \}_5\{P_2P_4 P_5 \}_6\{ P_1P_3\overline{P}_4 \}_7\} \quad (10.19)$$

On searched structure is imposed a condition so that its elements $P^{\sigma i}_i$ could create a partially ordered set a set which elements satisfy a relation of partial arrangement. it is described with the following properties:

- reflexivity:

$$\forall (P_i^{\sigma i} \in M)[(P_i^{\sigma i}, P_i^{\sigma i}) \in R] \quad (10.20)$$

- antisymmetry:

$$\forall(P_i^{\sigma i}, P_j^{\sigma j} \in M)\{[(P_i^{\sigma i}, P_j^{\sigma j}) \in R][(P_j^{\sigma j}, P_i^{\sigma i}) \in R] \rightarrow P_i^{\sigma i} = P_j^{\sigma j}\} \quad (10.21)$$

- transitivity:

$$\forall(P_i^{\sigma i}, P_j^{\sigma j}, P_k^{\sigma k} \in M)\{[(P_i^{\sigma i}, P_j^{\sigma j}) \in R][(P_j^{\sigma j}, P_k^{\sigma k}) \in R] \rightarrow (P_i^{\sigma i}, P_k^{\sigma k}) \in R\} \quad (10.22)$$

Graphic illustration of a partially ordered set is Hasse diagram which is a directed graph which was deprived of all loops (property of reflexibility) and closing bows (transitivity property). Examined possibilities of creation of logic structure (model ψ_b) are implemented in the scope of the following phases:

- construction of a model of propositional function,
- determination and elimination of forbidden figures from graph model of propositional function (semantic table),
- construction of graph model of operation $\psi_{a,}$,
- construction graph model of a structure ψ_b.

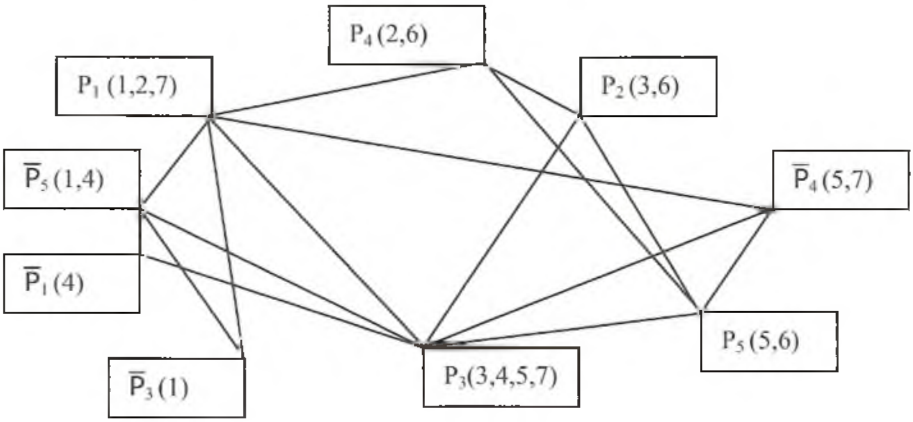

Fig. 10.2. Graph model of a function Source: own study

The analysis of all possible variants of Hasse diagram (2!*2!*3!*3!*3!*3!* 3!= 236196) do not bring to finding correct model of a structure ψ_a, because such solutions do not exist for the sake of the occurrence in graph model ψ_a forbidden graph figures in a form, graph sub-models Q_a and Q_b.

Fig. 10.3. Forbidden graph figures. Source: own study on the basis: [6]

Q_a figure is graph sub-model recorded in a form of cycle of odd length which vertexes-weighted are pairs of changing in cycle's weight being indexes of correct alternative terms [13].

Q_b figure is graph sub-model recorded in a form of triangle with pendulous vertexes. Vertexes of a triangle have the same weight and each of them have additional weight equal to pendulous vertex weight. A vertex of a triangle can also be one of two remaining vertexes of a triangle [13].

Graph model of propositional function includes (fig. 10.2) forbidden connections which do not correspond to any alternative term of logic statement that is contain forbidden sub-models Q_a and Q_b.

Forbidden graph figures of Q_a and Q_b types in analyzed example are as follows:

$Qa^1 = \{P_1(1,7,2)\ P_4(2,6)\ P_2(6,3)\ P_3(3,5,7,4)\ \overline{P}_5(4,1)\}$
$Qa^2 = \{P_1(1,2)\ P_4(2,6)\ P_2(6,3)\ P_3(3,4)\ \overline{P}_5(4,1)\}$
$Qa^3 = \{P_1(1,2)\ P_4(2,6)\ P_5(6,5)\ P_3(5,4)\ \overline{P}_5(4,1)\}$
$Qa^4 = \{P_2(6,3)\ P_3(3,4,7,5)\ P_5(5,6)\}$
$Qa^5 = \{P_2(6,3)\ P_3(3,5)\ P_5(5,6)\}$
$Qa^6 = \{P_1(1,7)\ P_3(7,4)\ \overline{P}_5(4,1)\}$

$Qb^1 = \{P_2(3,6)\ P_4(2,6)\ P_5(5,6)\}$
$Qb^2 = \{P_1(1,2,7)\ \overline{P}_4(5,7)\ P_3(3,4,5,7)\}$
$Qb^3 = \{P_1(1,7)\ \overline{P}_4(5,7)\ P_3(3,7)\}$
$Qb^4 = \{P_1(2,7)\ \overline{P}_4(5,7)\ P_3(3,7)\}$
$Qb^5 = \{P_1(1,7)\ \overline{P}_4(5,7)\ P_3(4,7)\}$
$Qb^6 = \{P_1(2,7)\ \overline{P}_4(5,7)\ P_3(4,7)\}$
$Qb^7 = \{P_3(3,4,7,5)\ \overline{P}_4(7,5)\ P_5(6,5)\}$
$Qb^8 = \{P_3(3,5)\ \overline{P}_4(7,5)\ P_5(6,5)\}$
$Qb^9 = \{P_3(4,5)\ \overline{P}_4(7,5)\ P_5(6,5)\}$

Variables splitting should be conducted in a way to eliminate all forbidden graph figures. For this purpose semantic table is constructed – table.3 which with the aid of 1 number designated occurrence of a propositional variable that is a vertex in forbidden graph figure.

Table 10.2. Semantic table. Source: own study on the basis [12]

	P_1 (1, 2)	P_1 (1, 7)	P_1 (2, 7)	P_2 (3, 6)	P_3 (3, 4)	P_3 (3, 5)	P_3 (3, 7)	P_3 (4, 5)	P_3 (4, 7)	P_4 (2, 6)	P_4 (5, 7)	P_5 (5, 6)	P_5 (1, 4)	P1 (1,2, 7)	P_3 (3,4,5, 7)
Qa_1	0	0	0	1	0	0	0	0	0	1	0	0	1	1	1
Qa_2	1	0	0	1	1	0	0	0	0	1	0	0	1	0	0
Qa_3	1	0	0	0	0	0	0	1	0	1	0	1	1	0	0
Qa_4	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1
Qa_5	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0
Qa_6	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0
Qb_1	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0
Qb_2	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
Qb_3	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0
Qb_4	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0
Qb_5	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0
Qb_6	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0
Qb_7	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1
Qb_8	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0
Qb_9	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0

As the forbidden figures are eliminated the splitting of a diagram can be completed. In this case three variables replica was formed: $P_2(3,6)$; $\overline{P}_4(5,7)$; $\overline{P}_5(1,4)$. Function $F(P^{\sigma 1}{}_1, P^{\sigma 2}{}_{2,\dots,} P^{\sigma 5}{}_5)$ takes the following form:

$$F(P^{\sigma 1}{}_1, P^{\sigma 2}{}_{2,\dots,} P^{\sigma 5}{}_5) = P_1\overline{P}_3\,\overline{P}_5 \vee P_1P_4 \vee P_2P_3 \vee \overline{P}_1P_3\overline{P}_{5'} \vee P_3\overline{P}_4P_5 \vee P_{2'}P_4\,P_5 \vee P_1P_3\overline{P}_{4'} \quad (10.23)$$

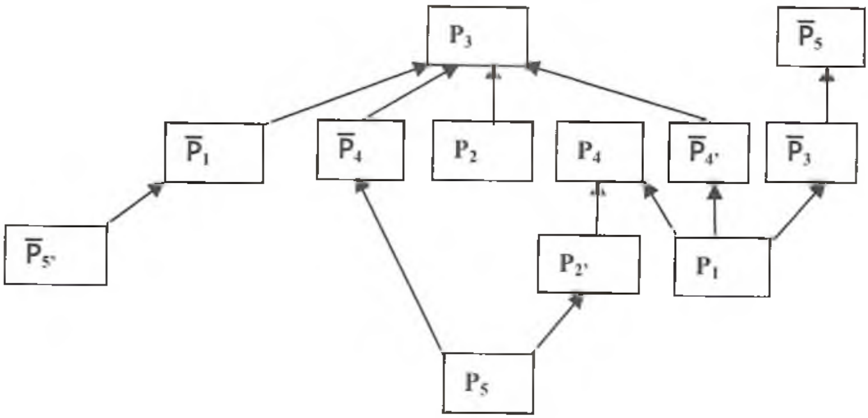

Fig. 10.4. Hasse diagram after the disposal of Q_a and Q_b figures in a operation model ψ_a. Source: own study on the basis [12]

As result of splitting three propositional variables new model of operation was obtained ψ_a, which corresponds to Hasse diagram and provides correct realization of propositional function. It means that the conformity of structure functioning obtained as result of the application of characterization theory expressed with a procedure of predicate implementation P_0 (ψ_a, ψ_b) for a propositional function described with a model ψ_a and logic structures described with a model ψ_b. New model ψ_a' takes the following form:

$$\psi_a' = \langle M', S_2', S_3' \rangle \tag{10.24}$$

$$M' = \{ P_1'\ \overline{P}_1'\ P_2'\overline{P}_2'\ P_3'\overline{P}_3' P_4'\ \overline{P}_4'\ P_5'\ \overline{P}_5' \} \tag{10.25}$$

$$S_2' = \{ \{ P_1' P_4' \}_2 \{ P_2' P_3' \}_3 \} \tag{10.26}$$

$$S_3' = \{\{ P_1'\overline{P}_3'\ \overline{P}_5'\}_1 \{\overline{P}_1' P_3'\ \overline{P}_5' \}_4 \{P_3'\ \overline{P}_4' P_5' \}_5 \{P_2' P_4'\ P_5' \}_6 \{ P_1' P_3'\overline{P}_4' \}_7\} \tag{10.27}$$

Due to the application of characterization principle it manager to change a process of generation, searching and analyzing of 236196 variants of logic structures in the analyze of simple semantic table. The result was possible as a result of preceded preparation of a theory of conditions transformation of a model ψ_a in a model ψ_b.

4. SUMMARY

As the example presents it, for the interpretation purposes – in the scope of characterization principles – detailed theory of forbidden, mandatory and neutral graph figures is formed which are used to homeomorphic transformations. Due to these transformations complex and expensive processes of alternative solutions testing are converted with proof of correctness of the operation.

Besides, the application of solutions on the basis of algebra of logic provides the possibility of other view on research problems solution, other than applied until now and these are greatly statistic methods. They can contribute to problems identification which were not noticed by schematic of applied solutions. In effect, is caused the increase of calculation possibilities of a change of added value produced by the implementation of a system of risk management.

REFERENCES

[1] Chlebus E., Burduk A., Modelowanie i symulacje ryzyka produkcyjnego, [in:] Zarządzanie produkcją i logistyka – koncepcje, metody i rozwiązania praktyczne, (red.) M.Fertsch, K.Grzybowska, A.Stachowiak, Monografia Instytutu Inżynierii Zarządzania Politechniki Poznańskiej, Poznań 2006.

[2] Foltys J., Determinants of trade through Internet. Ekonomika a Spolocnost, The Journal of Economics and Social Research, Wyd. Naukowe Uniwersytetu im. Mateji Bela, Bańska Bystrzyca, Slovakia 2/2004.

[3] Krupa T., Projektowanie strategii informatyzacji, [in:] Przedsiębiorstwo W Procesie Globalizacji. (red.) T. Krupa, WNT, Warszawa 2001.

[4] Krupa T., Koncept of Organisational Change. [in:] New Challenges and Old Problems in Enterprise Management, (ed. by:) T. Krupa, WNT, Warszawa 2002.

[5] Krupa T., Elementy organizacji. Zasoby i zadania., WNT, Warszawa 2006.

[6] Kulińska E., Ocena wpływu logistycznej struktury horyzontalnej na efektywność funkcjonowania przedsiębiorstw produkcyjnych, Wydawnictwo Politechniki Warszawskiej, Warszawa 2003.

[7] Kulińska E., Risk management versus value of logistics processes, [in:] Advanced Logistics Solutions, (ed.by:) prof. Vladimir Modrák, PhD, Prešov 2008.

[8] Kulińska E., Meaning of orientation on processes in creation and realization of the value added, Foundations of Management, vol.2/2009.

[9] Kulińska E., Risk management relation surplus value change of logistics processes, [in:] Invence – Inovace – Investice od recese k prosperitě – 2009, pp.415-420, Republika Czeska, Malenovice 2009.

[10] Kulińska E., An assessment model of axiological basis of logistics processes' risk management, International Journal of Production Economics, Imprint: ELSEVIER

[11] Kulińska E., Krupa T., Koncepcja oceny efektywności funkcjonowania przedsiębiorstw produkcyjnych-logistyczne podejście procesowe, [in:] Komputerowo Zintegrowane Zarządzanie, (red.) R. Knosala, WNT, Warszawa 2003.

[12] Kulińska E., Krupa T., Model oceny aksjologicznego wymiaru zarządzania ryzykiem procesów logistycznych, , p.80-86, Logistyka 4/2009.

[13] Nazaretow W.M, Kim D.P, Krupa T., Robotyka i elastycznie zautomatyzowana produkcja. Techniczna imitacja intelektu., WNT, Warszawa 1991.