

REVIEW

of the Ph.D. thesis in professional area 5.2 "Electrical systems, Electronics and Automatics", Ph.D. Program "Application of the principles and methods of cybernetics in different domains of science (technical sciences)"

Ph.D. student: Dilian Chavdarov Korsemov

Title of the Ph.D. thesis: Models and Algorithms to Support Group Decision-Making

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General description

The Ph.D. thesis contains 121 pages and is structured in introduction, 3 chapters, conclusion, contributions, list of publications, list of citations, declaration for originality and bibliography. The list of references contains 136 information and academic sources all in English.

1. Actuality of the investigated problem

The main contribution of the Ph.D. thesis concerns modifications of the common problem for group decision making. This modification allows to be taken into consideration more and additional parameters and factors, which influence the group decision making. The decision making problem is formalized as single optimization problem with additional integer variables and parameters, which consider the professional background and competence of the experts, involved into the group decision making. The solution of such kind of optimization problems gives benefits in sequential arranging of the decision solutions towards the best one. The formulated optimization tasks are solved by means of specialized software Lingo and Excel.

The Ph.D. thesis addresses the optimal decision making with participation of several experts, which forms the decision making group. A considerable part of the researches in the thesis is the application of the defined modified optimization problems in real cases as planning the implementation of corporative software resources, decision about the supplier selection in public procurement, decision about the choice of corporate software developer.

My personal evaluation about the problems and topics of the thesis is positive. The described investigations have pragmatic and useful values because they address real cases of public procurement and decision making. The relevance and significance of the Ph.D. topics is easy understood and doesn't need from additional considerations. By the development of new models for group decision making this thesis applies quantitative assessments, which are needed and welcomed for the solutions of the multi-criteria group decision making.

Hence the qualitative expectations for finding appropriate practical solutions is assessed and ranked in quantitative manner, reducing the negative subjective influences and lack of expertise.

The experiments in the Ph.D. thesis contain evaluations about the quantitative parameters of the solutions of group decision making problems. Added value of the researches is the application of the formal modified optimization problems in real cases of planning the implementation of corporative software resources, decision about the supplier in public procurement, decision about the choice of corporate software developer. All calculations are made with software suits EXCEL and Lingo, which proves the practical implementation of the modified optimization problems in information and software environment.

I find that the importance of the researches in the thesis is evident, the achieved results are useful and they prove a positive attestation and qualification of the author.

2. Degree of knowledge about the decision making state of the art and creative interpretation of the references

The Ph.D. thesis makes extended overview and analysis about the current technics, models, used in the domain of group decision making. This overview constitutes chapter 1. It has been presented models for choice of one alternative, assessed by several criteria; of several alternatives assessed by set of criteria; of set of alternatives by group of experts with a set of criteria (group decision making). The pragmatic value of this overview results in formalization of the decision process in specific form of optimization problem. This problem contains predefined number of alternatives (solutions of the optimization problem), predefined number of criteria and predefined member of experts in the decision group. The Ph.D. research modifies the common decision making optimization problem by the introduction of weighted parameters of preference and/or expert choices for these initial data. Thus a set of modified optimization problems are derived for group decision making process.

This chapter gives convincing proves about the knowledge of the author. He has deep learning in this scientific domain and he can precisely assess with his own criteria the available domain publications and academic sources about the group decision making. The Ph.D. thesis uses 136 references and sources. One can easily find that many of the cited references are up to date with publication in the time of 2016-2018. This is evidence that the candidate strive to follow and to use actual solutions and results in the domain of decision making in multi-criteria environments.

3. Compliance of the chosen research methodology for achieving the thesis' goal, tasks and contributions

The goal of the thesis is defined in the end of chapter 1 as "to develop a set of models for group decision making process" taking into consideration the differences in "the expertise of the decision makers". This goal has been decomposed to 4 tasks, which concerns the development of new modified optimization problems, implementation of algorithms for their solutions, assessment of the received solutions with the existing criteria of Wald, Laplace, Hurwitz, Savage.

The Ph.D. thesis targeted the development of such formal models, which deal with the multi-criteria nature of the group decision making. The multi-criteria character of the problems has been used for ranging in quantitative manner the solutions of the decision making. The defined optimization problems take into consideration not only the set of decision alternatives, the set of decision criteria, the competence of the experts but the modifications made by the author about the values of criteria weights, levels of competences, new integer variables. These modifications and complications

of the decision making optimization problem allow to be found the best decision solution and ranging the next solutions towards this complicated sets of decision criteria and experts.

Chapter 2 contains the researches about the new modifications of the models for group decision making considering the expertise of the decision makers. After the definition of optimization problems the appropriate algorithms for their solution are applied. A peculiar constraint for the decision problems is the expert numbers up to 5. The decision problem is formalized as a mathematical integer one, because new binary variables are introduced for identification of the chosen alternative as optimal group solution. This common decision (2.1) – (2.5) sequentially is complicated by means to tackle the importance of the assessment per every expert; to provide a new combined model for finding the best solution alternative; to find predefined number of “best” solutions; to range the problem alternatives towards the best one.

This chapter presents the main research achievements of the Ph.D. student. They concern the definition of the decision problem in the form of mathematical programming one, which formalizes the group decision making process. It has been given evidences that the author can deal with a complex optimization processing of data and this results in quantitative values prove of the best and/or optimal solution in group decision making.

The third chapter contains numerical simulations about the application in real cases of the derived modified optimization problems for group decision making. It has been considered the cases for: group decision making about planning the type of complex software suit, implementing functionality of ERP (Enterprise Resource Planning) system; decision about the supplier in public procurement; decision about the choice of corporate software developer. These cases are realistic and they illustrate and prove the added value of the researches in the thesis. Additionally they demonstrate the considerable internal complexity of the decision process. The complexity arises from the needs to define the set of appropriate problem solutions, the set of decision criteria, the choice made by a group of different experts. The subjective component in the multi-criteria decisions takes place in this research also for the definition of the weights of the criteria and the expert competences. It is evident that objective values of these parameters cannot be defined. But their inclusion in the problems for group decision making gives opportunity to be taken into considerations specific peculiarities of each decision making problem.

Nevertheless of the internal complexity of the process of group decision making, in the thesis has been developed and continuously applied a sequential procedure for problem definition and then solution of appropriate optimization problem. This sequential procedure allows the group decision making to be implemented as deterministic, not stochastic and occasional procedure, which for the last case can lead unfortunately to considerable increase of the time for making the decision.

I find that the research topic has research and practical applicable character. It has been analyzed a nontrivial process of group decision making, which contains multi-criteria choice. This case complicates the formalization of the decision process and results in definition of mixed linear-integer optimization problems. It has been derived several modifications of the common problem of group decision making. Respectively it has been used appropriate algorithm for solving the mixed linear-integer problems.

The Ph.D. candidate demonstrates good competence in the domain of multi-criteria group decision making, the definition and modification in scalar optimization problems.

It has been proved by the numerical simulations the application of the developed optimization problems in real cases. This is evidence that the author possesses deep knowledge about the methods and tools for group decision making.

4. Peculiarities of the Ph.D. thesis

For the implementation of the predefined tasks in the thesis, in chapter 1 has been overviewed the technics and models, applied in the group decision making. It has been commented and presented the content and the differences of the different decision making technics. This part of the thesis makes identification of all parameters, which can take place for the formalization of the decision process as optimization problem.

Chapter 2 contains the modifications of the common decision problem. The modifications concern the introduction of weights of preferences for the problem alternatives, weights of competence of the experts, weights of preference for the set of decision criteria. A general research method in the thesis is the definition and solution of appropriate optimization problem, which formalize the decision process. The problem is in the form of mixed linear-integer mathematical programming.

Chapter 3 contains the numerical simulations with the modified optimization problems. Three real cases has been defined and studied: planning the type of complex software suit, implementing functionality of ERP (Enterprise Resource Planning) system; decision about the supplier in public procurement; decision about the choice of corporate software developer. The solutions of the optimization problems have been done in EXCEL and Lingo software environments.

My personal conclusion is that the results achieved in the thesis' researches are realistic, useful and they illustrate well the content of the problem of group decision making process.

5. Research and application achievements in the thesis

In the Ph.D. thesis it has been provide formalization of the problem of group decision making. This formalization results in an optimization problem. A specific development in this thesis is the introduction of additional coefficients, which give weights to the different experts, decision criteria, and alternatives as solutions. The optimization problem belongs to class of the mathematical programming problems with mixed linear-integer variables. This class of problems is difficult to solve but for the case of multi-criteria and group decision making they give more solutions: the best solution in group decision; the first two solutions giving best assessments; to make a range of all decision alternatives towards the best one.

The presented investigations have scientific and implicational nature. It analyzed a complex process of multi-criteria decision making involving a group of experts.

My assessment is positive, concerning the results of the candidate. They have potential for real applications and prove usefulness and pragmatic utilization.

The thesis contains scientific and application achievements for the case of modeling and formalization of group decision processes involving multi-criteria decision making.

The pure application achievements are proved by numerical simulations in EXCEL and Lingo environments of realistic practical cases: planning the type of complex software suit, implementing functionality of ERP (Enterprise Resource

Planning) system; decision about the supplier in public procurement; decision about the choice of corporate software developer.

My assessment for these research and application achievements is that the thesis results satisfy the Ph.D. requirements. The candidate can provide by himself research and engineering activities, to apply informatics tools for the definition and solution of complex optimization problems for group decision making. The Ph.D. thesis contains advantages due to the application of the derived models in practical realistic cases and scenarios. It is evident from the descriptions and solutions given in the thesis that the candidate can address successfully additional cases of group and multi-criteria decision making.

During the acquaintance with the thesis the referee finds that all achieved results are due to personal works of the candidate.

6. Comparison and assessment with the National minimal requirements for awarding Ph.D. scientific degree

Seven publications are presented that correspond with the topics and problems described in the Ph.D thesis. Four of them are published in 2018. Three publications have SJR rank. Four publications are published in international scientific journals, one in a book published by Springer edition, and one report on a scientific conference abroad.

My assessment about these publications is that they exceed considerably the legislative requirements for awarding the educational and scientific degree "Ph.D." The results achieved in the thesis prove their importance and usefulness. For the publications, applied to the thesis are identified now four citations, which are illustrated in the documents of the thesis.

Following the legislative National minimal requirements for awarding the Ph.D. degree for the professional area 5.2 "Electrical systems, Electronics and Automatics" it is needed at least 30 points for the group of criteria G. The same number of points is required from the internal rules of Bulgarian Academy of Sciences and the Institute of Information and Communication Technologies (IICT). The evaluation of the achieved points by the candidate for criteria group G is 66.66, which considerable exceeds the required legislative and academic levels.

The referee assumes that the presented publications and the illustration of the estimated citations totally satisfy the internal academic criteria of IICT for the awarding of the educational and scientific degree "Ph.D.".

7. Significance of scientific and application achievements of the Ph.D. thesis

The candidate Dilian Korsemov demonstrates proficiency in using tools and methods for solving problems of group decision making. He has deep knowledge about the process of formalization of the decision making to optimization problem. The candidate was applied his own developments for numerical simulations of realistic and practical cases for group multi-criteria decision making. The program code, which has been developed and used in the thesis, is based on EXCEL and Lingo software environments. It was evident the aim of the candidate to lead the research results to practical applications in real cases for group decision making.

The referee assumes that the thesis developments are useful and they allow applications in practical cases.

The files of this procedure don't contain evidences and protocols for division the authors' participation in common academic publications.

8. Some suggestions and critics

I assess positively the presented form of the thesis. It gives evidences that the candidate has done considerable amount of research works.

The thesis is prepared carefully and the referee doesn't assume that he has to make remarks from formatting nature. From meaningful point of view I find that the thesis contributions are well and correct defines, following the initially defined thesis tasks.

As my personal opinion I would like to add a conclusion in the thesis contributions that parts or procedures of the group decision making can be performed in automation way with corresponding information systems.

The referee accept that the candidate Dilian Korsemov demonstrates in convincing way his research works and professional qualification to provide by his own researches in the domain of group decision making.

CONCLUSION

My assessment is positive for the resulting research and application contributions of the Ph.D. thesis of Dilian Korsemov. I assume that the legislative and academic requirements of Bulgarian Academy of Sciences and IICT are satisfied. All upper said gives me ground to give positive assessment to the presented thesis and to recommend to the Scientific jury to **award to Dilian Tchavdarov Korsemov** the educational and scientific degree "**Ph.D.**" for professional area 5.2 "Electrical systems, Electronics and Automatics" , Ph.D. Program "Application of the principles and methods of cybernetics in different domains of science (technical sciences).

14.08.2019

Referee:

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PUBLIC RELEASE**

Prof.D.Sc.,Ph.D.Todor Stoilov