**PhD student:** Mahtab Afsari

**Supervisor**: Prof. Krzysztof Santarek

# The Title of Dissertation:

## *Fuzzy GERT Algorithm for Research Projects Scheduling*

## Abstract

In this research, we try to find a solution for Fuzzy GERT (Graphical Evaluation and Review Technique) networks. Although most of project managers know about the benefits of GERT and Fuzzy GERT networks, they do not use them. In order to solve this issue we have tried to facilitate it and develop a novel software package. Although developing software for GERT network analysis is not easy because of its complexity in calculation and graphical problems, it can be possible.

First, we have developed a computer program for solving the Gavareshki Fuzzy GERT method to understand and identify influential factors that make Fuzzy GERT programming complex. This developed program is used only for very simple case studies and is not generally written for solving the Gavareshki method. After that, in order to understand which factors have an influence on the results of Fuzzy GERT outputs, we have prepared two questionnaires and gathered project manager's views. We have also planned a suitable algorithm by combining the Gavareshki, Itakura, and Nishikawa methods as well as the Neumann theories. We have categorized the Fuzzy GERT networks into three categories: simple, medium and complex. To distinguish the complexity degree in the fuzzy GERT networks, we have used the Expertise2Go inference engine by using some specific rules and prompts in deterministic and fuzzy situations. We have applied Triangular Fuzzy Numbers (TFN) for activity duration, and minimized the distance between these numbers. In addition, we have used eight different Genetic Algorithms. Six of them have been selected to apply in software. Then a software package is designed in ten versions according to different methods for simple and medium Fuzzy GERT networks.

We have used the Neural Networks approach for the complex GERT networks. We have used seven case studies to test and evaluate our method capabilities where six of them are provided from the IPeG (Institute of Product Development and Engineering Design) at Leibniz University of Hannover and one of them is a case study introduced by Gavareshki in a research article in Iran.

We have solved each case study with our ten different methods and other known scheduling methods, such as CPM, Fuzzy CPM, PERT, and the Probability GERT methods. All of these method's results are illustrated by radar diagram. These evaluations can be useful for determining how closed is project predictive duration to project actual duration in each method. We find out that in addition to the importance of the degree of closeness, there can be other important factors, such as risk, flexibility

and so on, to choose the best scheduling method. We have used the TOPSIS method as a decision technique to find the best method that is very close to the positive ideal solution and very far from the negative ideal solution. Moreover, in order to show the changes in the project duration for the case 4 and 5 according to the expert's risk taking-level, a sensitivity analysis is organized based on the α-cut approach for the Normal with MD and Normal without MD scheduling methods. The main contribution of this research is developing scheduling methods for the R&D project planning based on the project complexity variety under uncertainty. The results have shown that two proposed Genetic Algorithms have better results in comparison with all Fuzzy GERT methods and also common scheduling methods such as CPM, PERT, and Probability GERT methods.

**Keywords:** Fuzzy GERT, FANP, NN, Projects Scheduling, Genetic Algorithm, α-cut Approach


**List of publication:**

[1] Roland Lachmayer, Mahtab Afsari, Rashid Hassani, **C# method for all Types of Nodes in Fuzzy GERT**, International Journal of Artificial Intelligence and Neural Networks (IJAINN), ISSN: 2250-3749, vol. 5, no. 1, pp. 57-62, April 2015.

[2] Lachmayer. R and Afsari. M**, "Algorithm of Converting Fuzzy GERT into CPM for Research Project Scheduling With Case Study",** 8th International Conference of Project Management, 2012, Tehran, Iran.

[3] Lachmayer. R and Afsari. M**, "Fuzzy GERT method for Scheduling Research Projects",** 9th International Conference of Industrial Engineering, 2013, Tehran, Iran.

[4] R. Lachmayer, M. Afsari, R. Hassani (2014): "**C# method for all types of nodes in Fuzzy**" , Second International Conference on Advances in Social Science, Management and Human Behaviour, Oktober 2014, Zürich, Schweiz

[5] Prof. Roland Lachmayer; Afsari, Mathab (2016): "**Application of MATLAB software for modeling and analyzing Fuzzy GERT Networks**", 12th International Conference on Industrial Engineering (ICIE 2016).