



## Dwelling selection by applying fuzzy game theory

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The paper describes model of dwelling selection, using fuzzy games theory. Two types of buildings are under consideration: traditional single flat dwelling house and loft flat dwelling house. Four alternatives of heating system are taken into account: coal based, gas based, biomass based, and combined biomass and gas based systems. Alternatives are described by a criteria set. Values of the criteria are determined by simulation and according to the statistic. Fuzzy games are applied for decision aiding. The problem solution result shows that fuzzy matrix games theory is appropriate for such purposes.

Keywords: *dwelling, alternative, selection, multiple criteria, fuzzy, game theory, MCDM, heating system*

### 1. Introduction

Decision making in real life is selection process among feasible alternatives, taking into account several criteria. Various decision making approaches have been proposed to tackle the problem. The Multi-Criteria Decision Aid (MCDA) has been one of the very fast growing areas of Operations Research during the last decade. The MCDA often deals with ranking of alternatives from the best to the worst ones based on multiple criteria [3]. Traditional optimization, statistical and econometric analysis approaches used within the engineering context are often based on the assumption that the considered problem is well formulated and decision-makers usually consider the existence of a single objective, evaluation criterion or point of view that underlies the conducted analysis [53]. Since the suitability of a dwelling-house for living depends on a number of attributes, like temperature, noise isolation, annual heat requirements, etc., a multi-attribute decision making (MADM) methods are used for their assessment [18]. Multi-criteria classification problems have gained significant interest among researchers working on MCDA [8]. The criteria are often qualitative and conflicting. A decision should be made by taking relevant opinions from the experts because inherent complexity and uncertainty in a business environment necessitate the participation of many experts in the decision making process [28].

In contemporary management, the performance is evaluated against multiple criteria rather than considering a single factor-cost [11]. In decision-making involving multiple criteria, the basic problem stated by analysts and decision-makers concerns the way by which the final decision should be made [13]. Multi-criteria decision making (MCDM) is not a prescriptive answer but a transparent and informative decision proc-

ess which helps to uncover how peoples' intuitive decision procedures can be informed by a structured rational analytic process [1]. MCDM is concerned with the ranking of decision alternatives based on preference judgements made on decision alternatives over a number of criteria [7].

Fuzzy theory has been regarded as a very important technique for quality management of distributed manufacturing system and attracts the attentions of academic and industry [46].

Model and using of dwelling selection, based on fuzzy game theory, is described in this paper.

The rest of the paper is organized as follows: section 2 shows game theory application in engineering, according on the literature review; section 3 describes a review of fuzzy sets in multi-criteria decision making, short about fuzzy theory authors and detail about investigation methodology of fuzzy set theory and fuzzy games, and review of case study; section 4 is dedicated for results and discussion; section 5 summarize the conclusions.

## **2. Game theory application in engineering**

Game theory is developed to study decision making in situations of conflict and sometimes cooperation. Game theory provides a mathematical process for selecting an optimal strategy [22]. Game theory can be applied to solve decision-making problems in engineering. That approves some works of scientists, which published their researches in this area:

In the field of Civil Engineering one of the first authors was professor Peldschus [29, 31], who used game theory and fuzziness in MCDM. A review of his works is focused in publication of Kapliński and Tamošaitienė [19].

Hennet and Arda [10] evaluated the efficiency of different types of contracts between the industrial partners of a supply chain. The model combines queuing theory for evaluation aspects and game theory for decisional purposes.

Liu et al. [24] proposed a method for multi-objective categorization based on the game theory and Markov process. They adopt Shapley value in coalitional games to measure the player's satisfaction degree in a group.

Sharma and Gopal [39] presented new direction that seeks to synergize broad areas of Reinforcement learning and Game theory, as an interesting and challenging avenue for designing intelligent and reliable controllers.

Long and Yu [25] applied the game theory to analyze the optimal strategy between the government and the enterprises in the process of implementing energy-saving and emission-reduction action, to get a mixed strategy Nash equilibrium solution.

Charilas and Panagopoulos [6] collected applications of game theory in wireless networking and presents them in a layered perspective, emphasizing on which fields game theory could be effectively applied.

Bompard et al. [4] presented a medium run electricity market simulator based on game theory.

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