

Chapter 9

Application of Fuzzy Soft Set in Patients' Prioritization

Samira Abbagholizadeh Rahimi
Université Laval, Canada

ABSTRACT

Based on studies, access to healthcare services and long waiting time is one of the main issues in many countries including Canada and United States. Healthcare organizations can't increase their limited resources nor treat all patients simultaneously. Then, patients' access to these services should be prioritized in a way that best uses the scarce resources and insures patients' safety. Prioritization is essential and inevitable not only because of resource shortage, which have not been improved during years, but also because it is a crucial issue that could contribute to the capability and stability of the healthcare systems, and most importantly to patients' safety. On the other hand, inappropriate prioritization of patients waiting for treatment, could affect directly on inefficiencies in healthcare delivery, quality of care, and most importantly on patients' safety and their quality of life and satisfaction. Inspired by these facts, in this chapter the importance of patients' prioritization and using fuzzy logic in this area will be discussed, and a novel hybrid framework using fuzzy soft sets for patients' prioritization will be proposed. The proposed framework may have a significant impact on patients' safety, and on both medical community and the public's faith in justice and equity.

INTRODUCTION

Medical knowledge and clinical practices are always associated with considerable amounts of uncertainty and about everything in medicine is inevitably vague (Sadegh-Zadeh, 2012). Many complicated problems like patients' prioritization problem involves such uncertainties. Despite this issue's importance, (to the best of our knowledge) no valid tool has been proposed in the literature to prioritize patients for medical treatment considering these uncertainties, and associated risks all together. To this end, this chapter will give useful impulses to face these major challenges in patients' prioritization, by developing a novel integrated framework which covers the current drawbacks and will provide theoretical solutions for them. This chapter focuses on uncertainties in clinicians' decisions and involving associated risks that could threaten patients while they are waiting for treatment, and proposes a novel integrated framework to deal with these crucial issues.

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This problem, cannot be solved using classical mathematic methods. There are several well-known theories (such as theory of probability, theory of fuzzy sets, theory of vague sets, theory of interval mathematics, and etc.) to describe uncertainty, but all of these theories have their inherent difficulties as Molodtsov (1999) mentioned in his paper. The reason for these difficulties is, possibly, the inadequacy of the parameterization tool of the theories (Celik & Yamak, 2013). To overcome these difficulties, Molodtsov initiated the concept of soft sets as a new mathematical tool for dealing with uncertainties (Molodtsov, 1999). This so-called soft set theory seems to be free from the difficulties affecting the existing methods (Maji et al., 2003).

Maji et al. (2001) defined various operators for soft set theory. and in 2010, Ali & Shabir (2010) made some improvements of the introduced operations by Maji et al. Fundamental properties of soft sets has been defined by Aktas and Cagman (2007). They combined the soft set theory and group theory to defined soft groups. Some new operation were studied in Ali & Shabir (2010), Ali et al. (2009), and Feng and Li (2013). They gave the new concept of the soft product in soft set theory and discussed generalized decision making schemes, and many other researchers such as Li (2014), Li and Ren (2015), and Yu and Li (2014) have studied soft set theory in different aspects.

Recently, research works on soft sets in different industries are very active and progressing rapidly. Applications of fuzzy soft set theory in many disciplines and real life situations have been studied by many researchers but, its application in healthcare industry is in its infancy stages. To the best of our knowledge this is the first time in literature that such novel integrated framework is introduced for patients' prioritization. This chapter focuses on developing an interdisciplinary, systematic and innovative prioritization framework which is inspired by Celik and Yamak (2013) work on medical diagnosis. The proposed framework considers uncertainty, multiple criteria, risks and their inherent interactions to prioritize patients' access to healthcare services. In this chapter, Analytical Network Process (ANP) is used to find relative importance weights of criteria and risks considering their possible interactions. Then, by using the notion of a fuzzy soft set together with arithmetic operations on fuzzy number, authors introduce how fuzzy soft set technology could be used for patients' prioritization.

The rest of the chapter is organized as follows. In the next two sections prioritization of patients' access to healthcare services, the related literature review and shortcomings are discussed in details. Basics of Fuzzy soft set theory are explained briefly after. Then the proposed framework is discussed. To illustrate the application and effectiveness of the proposed framework, a numerical example in surgery ward is illustrated. In order to demonstrate robustness of the proposed method, sensitivity analysis under various criteria/risks-weight-change scenarios is performed and the results are discussed. Finally, the proposed framework is compared with some of well-known Multi Criteria Decision Making (MCDM) methods in the comparison section to show its benefits and advantages. This chapter concludes with a summary of the chapter, a discussion on the major contribution of this framework and future directions.

PRIORITIZING PATIENTS ACCESS TO HEALTHCARE SERVICES

Patients in the Organization for Economic Co-operation and Development (OECD) countries (including United States and Canada) continue to wait too long to receive medically necessary treatment. Waiting times' situation not only have not been improved during years till 2016, but also they have gotten slightly worse (Barua, 2015). One of the main reasons for long waiting times is imbalance between demand and availability of scarce resources in healthcare organizations. Clinicians can't treat all patients simultane-

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