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# Analyzing ethical practices in the public healthcare sector using fuzzy cognitive mapping

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## Abstract

This study focused on some of the most important aspects of ethics in the healthcare industry and examined the relevance of the system created to evaluate ethical healthcare practices in the public sector. The research included developing a conceptual model representing variables that influence ethics in public healthcare services in Portugal, using fuzzy cognitive mapping to facilitate the identification of the most significant variables. This method is a well-established decision problem-structuring tool that allows experts to define cause-and-effect relationships between variables and make decisions. The insights obtained were generated in face-to-face group meetings with experts in the public healthcare sector, showing that *professional profiles*, *management*, *team relationships*, *external factors*, *equity principles*, and *respect* are among the most relevant determinants of ethical healthcare. That is, these criteria are the most commonly applied standards in analyses of ethical practices in public healthcare services. The resulting assessment framework and its applicability were validated by both the panel of experts and the chairperson of the board of directors of S. Francisco Xavier Hospital in Lisbon, Portugal. The advantages and limitations of the analysis developed in this study are also discussed.

**KEYWORDS**

decision support system, ethical practice, fuzzy cognitive mapping, healthcare sector, public healthcare system

## 1 | INTRODUCTION

In recent years, ethics has emerged as a significant field of research in the healthcare sector (Molterer, Hoyer, & Steyaert, 2020; Tepper, 2017). The increasing evolution of medical knowledge and concurrent technological advances have highlighted the need to create models that support analyses of ethical practices and decision making in this sector. Emanuel (2000), George (2016), Pasricha, Singh, and Verma (2018), and Wu, Liao, Chiu, Lin, and Yang (2011), among others, stress the importance of organizational ethics, stating that organizations and structures, similar to individuals, have ethical attributes and these non-person entities can be considered morally responsible. Ethical principles in organizations need to represent intrinsic values that help to clarify the moral aspects relevant to problem solving (Grigoroudis, Orfanoudaki, & Zopounidis, 2012; Nunes, 2017; Winkler & Gruen, 2005). Therefore, experts have given increasing importance to studying the impacts of ethical practices on the health sector.

The main objective of the present study is to develop a reference model that identifies and elucidates the dynamics behind cause-and-effect relationships between the variables that explain ethical practices in national healthcare services (NHS). To build this conceptual model, fuzzy cognitive mapping was applied. A panel of experts with know-how and experience in the area under study was created to promote reflection and discussion based on fuzzy cognitive mapping techniques. The group work sessions facilitated the structuring of the decision problem and specification of relevant information during the model construction.

  

Fuzzy cognitive mapping is based on a constructivist view. With this well-established problem-structuring method, decision makers can, first, structure the decision problem under analysis and, second, determine which variables should be incorporated in the evaluation mechanism. The third and fourth applications are support for decision making and clarification of cause-and-effect relationships between variables, while the last function is to define well-focused improvement initiatives. The application of fuzzy cognitive mapping is justified by not only its inherent mathematical basis but also its simplicity and interactivity. According to Kosko (1986), and Salmeron (2012), fuzzy cognitive maps (FCMs) combine elements of neural networks with fuzzy logic and, as mentioned previously, FCMs are associated with a constructivist approach to decision making (Pires, Ferreira, Jalali, & Chang, 2018; Santos, Ferreira, & Meidutė-Kavaliauskienė, 2018).

In the present study, two sessions were conducted with an expert panel to gather the information needed to construct an FCM. After the panel validated the resulting assessment model, the relevance of each variable was analyzed. This type of model has the potential to be a critical tool in strategic planning and team management and in the identification of key areas needing improvement within internal systems and processes (Azevedo & Ferreira, 2019; Branco, Ferreira, Meidutė-Kavaliauskienė, Banaitis, & Falcão, 2019; Carlucci, Ferreira, Schiuma, Jalali, & António, 2018). A review of the literature revealed no prior evidence of the use of this methodological approach in public healthcare research, which means this article offers a valuable contribution to the extant literature on ethics, healthcare services, and management science/operational research (MS/OR).

The article is organized as follows. Section 2 presents a review of the literature on ethics and models of ethical practice analysis in the healthcare sector. Section 3 provides the methodological context. Section 4 describes the model-building process applied, including a discussion of the results and their limitations. Finally, Section 5 summarizes the study's main conclusions and provides directions for future research.

## 2 | LITERATURE REVIEW AND RESEARCH GAP

The ethical concepts applied in the healthcare sector have evolved over time. In the early 20th century, Ross (1930) refined Kant's deontological concepts, defining prima facie duties as: (a) fidelity; (b) reward; (c) gratitude; (d) non-maleficence; (e) justice; and (f) beneficence (cf. Lawson, 2011). In the 1970s, Beauchamp and Childress (1979) formulated four principles of biomedical ethics: beneficence; non-maleficence; justice; and autonomy. These provide a coherent approach to ethical decision making in medical contexts, and these principles have since become the standard model for ethical medical practices.

However, with constant complex changes taking place in the healthcare sector (Fragkiadakis, Doumpos, Zopounidis, & Germain, 2016), new lines of thought have emerged in the field of medical ethics. Tepper (2017) argues that, in addition to Beauchamp and Childress's (1979) four fundamental principles, two other closely related ideas are fundamental to clinical ethics. These new principles are: respect for the individual, in which patients have the right to be treated with dignity; and truth and honesty, which is an idea closely linked to the concept of informed consent. Rehbock (2011) also asserts that the principle of autonomy is closely related to the moral and legal claims of informed consent.

Another fundamental ethical concept in healthcare is accountability (Emanuel, 2000). Emanuel (2000) identifies the following five domains of accountability: (a) competence; (b) access to healthcare; (c) public health and community benefits; (d) legal and ethical practices; and (e) financial performance. Pinto (2012) also defines five essential ethical principles in healthcare. The first is respect for human dignity and freedom, which is enshrined in the Universal Declaration of Human Rights. The second is the defence of human life from conception to death, while the third is universal healthcare. The fourth principle is freedom of choice through informed consent, and the last is respect for the therapeutic properties of spirituality in care.

In addition, Nunes (2017) lists the organizations that have formulated fundamental ethical principles that must be universally respected. These include the Nuremberg Code, the Helsinki Declaration, the European Council Convention on Human Rights and Biomedicine, and the United Nations Educational, Scientific, and Cultural Organization's Universal Declaration on Bioethics and Human Rights. Another especially pertinent set of principles are the International Ethical Guidelines for Health Research of the Council of International Organizations of Medical Sciences. According to Nunes (2017), the seven key principles include, first, respect for each person and free and informed consent. The second and third principles are protection of vulnerable individuals, for example, children and psychiatric patients, and the maximization of benefits and minimization of harm (i.e., beneficence and non-maleficence). The last four principles are privacy and confidentiality, justice and/or equity in access to healthcare and clinical trials, obligations of healthcare professionals and institutions, and responsibilities of ethics review committees.

Given this reasoning, the discussion about medical ethics appears to have focused mainly on how healthcare professionals should behave individually, and thus less attention seems to have been paid to the behavior of the organizations to which healthcare providers belong. Organizational ethics must concentrate on organizational observance of ethical principles (Wu et al., 2011). Emanuel (2000) and George (2016) stress the importance of this level of ethics, stating that organizations and structures, similar to individuals, have ethical attributes and that organizations can be considered morally responsible. According to Carrol (1991), organizational ethical responsibility encompasses values and norms society expects institutions to adopt. This responsibility includes standards, rules, or expectations, reflecting the concerns of all stakeholders (i.e., consumers, employees, shareholders, and the broader community). Thus, corporate ethics and, in particular, stakeholder theory can contribute to thinking about organizational ethics in healthcare (Werhane & Rorty, 2000). Part of the expected conduct of healthcare professionals is the responsibility to

**TABLE 1** Studies related to healthcare sector ethics

| Authors | Methodology | Features | Limitations |
|---|---|---|---|
| McDevitt, Giapponi, and Tromley (2007) | Janis and Mann's decision-making model | Helps to understand the complexity of decision-making processes in ethical dilemmas and suggests appropriate interactions | • Fails to consider the impact of time on decision-making processes<br>• Neglects to determine when the proposed method can affect ethical decisions |
| Schumann and Alfandre (2008) | Case study using a method based on four topics: Medical indications, users' preferences, quality of life, and contextual characteristics | Guides discussion among team members, users, and family members to reach solutions that respect users' values and preferences | • Excessively simplifies the case<br>• Offers a challenging operationalization of the four topics<br>• Only applies to healthcare |
| Schlairet, Kiser, and Norris (2012) | Case study | Steers patients, families, and professionals through decision-making processes and resolutions of ethically complex situations | • Provides results that are useful only in less ethically complex situations<br>• Offers limited applications to palliative care |
| Knox (2014) | Ethnographic method | Promotes collaboration and an interdisciplinary approach to analysis | • Applies only to neonatal intensive care units |

act ethically in everything they do (George, 2016). This assumption has led healthcare organizations to recognize the importance of adopting and monitoring ethical practices and, therefore, to the creation of hospital ethics committees worldwide. In Portugal, for instance, the NHS has acknowledged the need to stimulate reflection on ethical issues and created a new type of autonomous advisory body (i.e., the Ethics Committee for Health [ECH]). Every hospital, local medical centre, and public healthcare institution has its own ECH.

Harris (2003) argues that ethical principles are neither the beginning nor the end of the ethical reflection process. These principles may be a useful approach—a "checklist" that has been mostly used in bioethics and by ethics commissions—but this approach "*lead*[s] *to* [a] *sterility and uniformity of approach of a quite mind-bogglingly boring kind*" (Harris, 2003, p. 303). McGovern (2016) reinforces this idea by stressing that following a "checklist" in medical ethics implies that medical professionals are morally obtuse and unable to engage in regular human interactions without having guidelines or a map. Lawson (2011) also points out the limitations of the principle approach. According to the author, verifying and sorting out principles in complex situations is difficult and, as conflicts can arise between principles, solutions cannot be found simply by invoking established principles. The "checklist" approach has thus not generated a consensus among experts, who still debate whether this is an appropriate approach to ethical decision making in healthcare. The lack of agreement is unsurprising given the complex and contentious nature of ethics and ethical decisions. In contrast, "mainstreaming" ethics has become one of the most common and accepted approaches to understanding ethical issues in healthcare and ethical decision making (cf. Wagner & Dahnke, 2015).

According to Campbell (2003), despite the competition between the above ethical theories, none overlaps with other ethical dilemma theories or analysis models developed in other fields. In addition, the available models can be combined to provide more adequate analyses than when each is applied individually. Knox (2014, p. 121) reports that "*many reflective models have been developed over the years*. […] *all these models intend to foster reflection to improve thoroughness in monitoring and managing ethical decision making*". Table 1 summarizes the contributions and limitations of some models and/or methodologies used to analyze ethical practices in the healthcare sector.

The literature analysis exemplified in Table 1 supports the conclusion that the evolution of medical knowledge and technological advances have produced a growing need to create models that support both decision making and analyses of ethical practices. All previously presented models have limitations, however, and these approaches are not applicable to analyses of ethical practices in all NHS, which emphasizes the importance of focusing on the decision problem under study.

Specifically, the investigations carried out thus far present three general limitations. These are: (a) the methodologies used are not applicable in different contexts; (b) the number of factors identified is relatively small; and (c) statistical methods are incapable of representing the cause-and-effect relationships between variables. Indeed, it is widely known that, despite the fact that statistical models are by far the most popular approach, they impose rigorous distributional assumptions, require particular scaling properties of the data, and are limited in flexibility (Carayannis, Ferreira, Jalali, & Ferreira, 2018; Ferreira, Meidutė-Kavaliauskienė, Zavadskas, Jalali, & Catarino, 2019). Therefore, the present study sought to develop a comprehensive cognitive structure representing determinants of NHS ethical practices and to identify the primary factors affecting the adoption of these practices. To this end, fuzzy cognitive mapping was used to ascertain these determinants and analyze their cause-and-effect relationships.

## 3 | METHODOLOGY

### 3.1 | Problem structuring and cognitive mapping

According to Midgley et al. (2013), problem-structuring methods (PSMs) are a subset of participatory methods used in interventions intended to stimulate deliberative dialogue and proposals for change. This type of method facilitates the involvement of decision-making stakeholders to address complex organizational, social, environmental, or technological issues (Beierle & Cayford, 2002; Martins, Ferreira, Ferreira, & Marques, 2020; Midgley et al., 2013). PSMs seek to provide analytical assistance in problematic decision-making situations. These situations are characterized by: (a) multiple actors; (b) different perspectives; (c) partially conflicting interests; (d) significant intangibles; and (e) uncertainty (Mingers & Rosenhead, 2004; Pereira, Ferreira, & Chang, 2019; Rosenhead, 2006).

Cognitive mapping is a PSM (Ackermann, 2012; Marttunen, Lienert, & Belton, 2017; Vaz de Almeida, Ferreira, & Ferreira, 2019; Vidal, 2004). Tegarden and Sheetz (2003) assert that this practice produces illustrations of concepts and criteria, analyzes them, and identifies cause-and-effect relationships through graphic representations. Cognitive mapping thus promotes the structuring of complex decision problems and allows the resulting structures to be used in decision making (cf. Carlucci et al., 2018). The latter are metacognitive tools used as instruments in experience-centred thinking that facilitate the definition of strategic guidelines (Ackermann & Eden, 2001; Eden, 2004; Eden & Ackermann, 2004; Ferreira, Jalali, Meidutė-Kavaliauskienė, & Viana, 2015; Howick & Eden, 2011). In this sense, cognitive maps are simple, interactive, and versatile. These maps can be used to "*promote discussion amongst* […] *decision makers*, […] *reduce the omission* […] *of important criteria*[,] *and* […] *increase learning based on a deeper understanding of the causal relations*[hips] *between criteria*" (Ferreira, Spahr, Santos, & Rodrigues, 2012, p. 260). Therefore, cognitive maps have two fundamental functions: (a) descriptive (i.e., visually depicting the problem); and (b) reflective (i.e., generating new ideas) (Carlucci et al., 2018; Ribeiro, Ferreira, Jalali, & Meidutė-Kavaliauskienė, 2017).

### 3.2 | Fuzzy cognitive mapping

Kang, Deng, Sadiq, and Mahadevan (2012) define FCMs as an extension of cognitive maps. They were developed by Kosko (1986) based on Axelrod's work as a way to capture visually and logically cause-and-effect relationships between elements in a given decision problem (cf. Hester, 2015). According to Carlucci, Schiuma, Gavrilova, and Linzalone (2013, p. 208), "*FCM is a well-established artificial intelligence technique, incorporating ideas from artificial neural networks and fuzzy logic, which can be effectively applied in the domain of management science*". The main objective of FCMs is to predict the outcome of decision problems by allowing relevant concepts to interact with each other (Froelich & Salmeron, 2017; Papageorgiou & Salmeron, 2013).

FCMs consist of a structure made up of concepts and respective connections, which describes the behavioral characteristics of a system and is presented in a graphic format. This graphical representation is composed of concepts—also called decision criteria, factors, components, or variables—that are connected by interactions, arrows, or arcs. Decision makers can use FCMs to understand the cause-and-effect relationships between decision criteria more easily as these maps demonstrate concepts' interactivity and different aspects of the variables under study (Groumpos, 2015; Kang et al., 2012; Kardaras & Mentzas, 1997; Ziv et al., 2018).

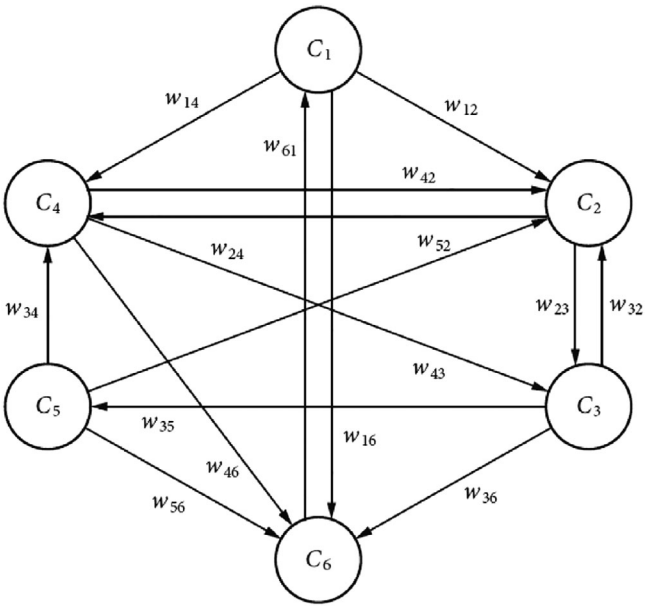


**FIGURE 1** Example of an fuzzy cognitive map (FCM). *Source:* Kang et al. (2012, p. 78)

Concepts in FCMs represent system characteristics, which are connected by a network of interactions (Lousada et al., 2021; Ziv et al., 2018). When arrows are included, they indicate weighted connections and represent causal (i.e., cause-and-effect) relationships among the concepts of the cognitive structure (Kang et al., 2012). Figure 1 offers an example of an FCM consisting of six concepts ($C_i$ [$i$ = 1, …, 6]).

The weight $w_{ij}$ varies in the interval [−1, 1] and represents the cause-and-effect relationship between concept $i$ and concept $j$ (Kang et al., 2012). Causal relationships between criteria or concepts can include three types of interactions. The first is $w_{ij} > 0$, which indicates a positive causality (i.e., an increase [decrease] of the value of $C_i$ leads to an increase [decrease] of the value of $C_j$). The second interaction is $w_{ij} < 0$, which indicates a negative causality, in which an increase (decrease) in the value of $C_i$ causes a decrease (increase) in the value of $C_j$. The last interaction is $w_{ij} = 0$, which indicates that no cause-and-effect relationship exists between $C_i$ and $C_j$ (i.e., the concepts do not influence each other) (Groumpos, 2015; Kang et al., 2012). The greater the absolute value of $w_{ij}$, the stronger the influence of $C_i$ on $C_j$ is, either directly (i.e., positive causality) or inversely (i.e., negative causality) (Groumpos, 2015; Papageorgiou & Salmeron, 2013).

The value of each concept is calculated by considering the influence of other concepts on that concept and the influence of that

same concept on other concepts (Groumpos, 2015; Kang et al., 2012; Papageorgiou, Roo, Huszka, & Colaert, 2012). Any interaction introduced into an FCM translates into an effect of change, which can be calculated using Formula (1):

$$A_i^{(t+1)} = f\left(A_i^{(t)} + \sum_{\substack{j=1 \\ j\neq i}}^{n} A_j^{(t)} \cdot w_{ji}\right), \quad (1)$$

in which $A_i^{(t+1)}$ is the value of the concept $C_i$ at time $t + 1$. In addition, $f(x)$ is the activation function, $A_j^{(t)}$ is the value of the concept $C_j$ at time $t$, and $w_{ji}$ is the weight of the cause-and-effect relationship between the concepts $C_j$ and $C_i$ (Ferreira, 2016; Groumpos, 2015; Kang et al., 2012).

Notably, the function $f(x)$ can take four forms: (a) binary; (b) trivalent; (c) sigmoid; and (d) hyperbolic tangent (Azevedo & Ferreira, 2019; Hester, 2015; Tsadiras, 2008). The binary and trivalent functions are essential to qualitative problems, and the sigmoid function is fundamental in quantitative and qualitative problems and strategic planning in scenario analysis (Tsadiras, 2008). The hyperbolic tangent function assumes a function similar to the sigmoid function, and its use is only distinguished by the concepts' semantic capability, known as the "state vector" (Glykas, 2013).

Given the above specifications, FCMs allow for both static and dynamic system analyses (i.e., through scenario simulations) (Azevedo & Ferreira, 2019; Ferreira, 2016). These types of analysis also allow researchers to formulate "what-if" questions, that is, to understand the impact on decisions of altering or excluding specific concepts or even including new variables (Carvalho, 2013; Ferreira, 2016; Ferreira & Jalali, 2015), which seems to be of great importance in the analysis of NHS ethical practices.

## 4 | APPLICATION AND RESULTS

### 4.1 | Participants

To make fuzzy cognitive mapping possible, a panel of specialists had to be recruited from among the decision makers with specialized know-how in the area under study (see Stylios and Groumpos (2007)). According to Eden and Ackermann (2004), and Ribeiro et al. (2017), this kind of panel should have between 6 and 10 elements. In the present study, the panel had seven members, aged between 33 and 69 years, with different areas of healthcare expertise (i.e., doctors, nurses, radiology technicians, and physiotherapists). These experts also had different functions and responsibilities in terms of decision making (i.e., professionals with a variety of management responsibilities). The selection criteria guaranteed a more holistic perspective on the decision problem in question (cf. Belton, Ackermann, & Shepherd, 1997). The process-oriented nature of the methodological framework applied in the current research needs to be highlighted here. The objective was not to produce results representative of all NHS ethical practices but instead to discuss the topic with multiple area experts. According to Bell and Morse (2013, p. 962), this approach means "*less emphasis on outputs per se and more focus on process*".

The application of cognitive mapping techniques requires that group meetings be held in the presence of, and conducted by, facilitators/researchers. The sessions each had an average duration of 4.5 hr, and two facilitators (i.e., two of the authors of this study) attended each meeting. According to Ferreira (2016), the facilitators' role is to support the negotiation process and guide the procedures followed to build the evaluation model.

### 4.2 | Cognitive map construction

Fuzzy cognitive mapping consists of three stages: (a) identification of concepts; (b) identification of cause-and-effect relationships; and (c) intensity aggregation (Zhang, Chettupuzha, Chen, Wu, & AbouRizk, 2017). Ferreira (2016) suggests that facilitators start the FCM development by asking the panel a trigger question to promote discussion. In the present study, the trigger question was as follows: "*Based on your values and professional experience, what are—or should be—the determinants of ethical conduct in the NHS?*". This question was asked after the facilitators had given a brief presentation of the main objective of the study, the methodology to be applied, the purpose of each session, and the process to be followed. The determinants (i.e., variables or criteria) included in the evaluation system were identified by applying the "post-its technique" (Ackermann & Eden, 2001). This consists of writing on post-it notes the criteria each decision maker considers relevant to the decision problem under study. Each post-it note can only contain one criterion, and this should be marked with a negative sign (–) if the cause-and-effect relationship has a negative impact (Azevedo & Ferreira, 2019).

After the experts identified the key variables in analyses of healthcare ethics, the panel grouped the post-its into five clusters: (a) *Professional Profiles*; (b) *Management*; (c) *Team Relationships*; (d) *External Factors*; and (e) *Equipment and Processes*. Finally, the decision makers were asked to rank the variables within each cluster in descending order of importance so that the most significant ones were placed at the top of the cluster and the least relevant ones at the bottom. The final version of the map was developed using the *Decision Explorer* software (www.banxia.com), and validated by the panel of experts at the beginning of the second group work session. Figure 2 shows the cognitive structure developed (size restrictions prevent a better visualization, but an editable version of the group cognitive map can be obtained from the corresponding author upon request).

The cognitive map presented in Figure 2 comprises 152 concepts related to ethical practices in NHS, falling under the heading of "*Ethics in Public Healthcare Services*," which corresponds to the objective of the study. According to Ferreira, Jalali, and Ferreira (2016), the volume of information contained in the map facilitates a more holistic view of the decision problem and a fuller understanding of the cause-and-effect relationships between criteria.

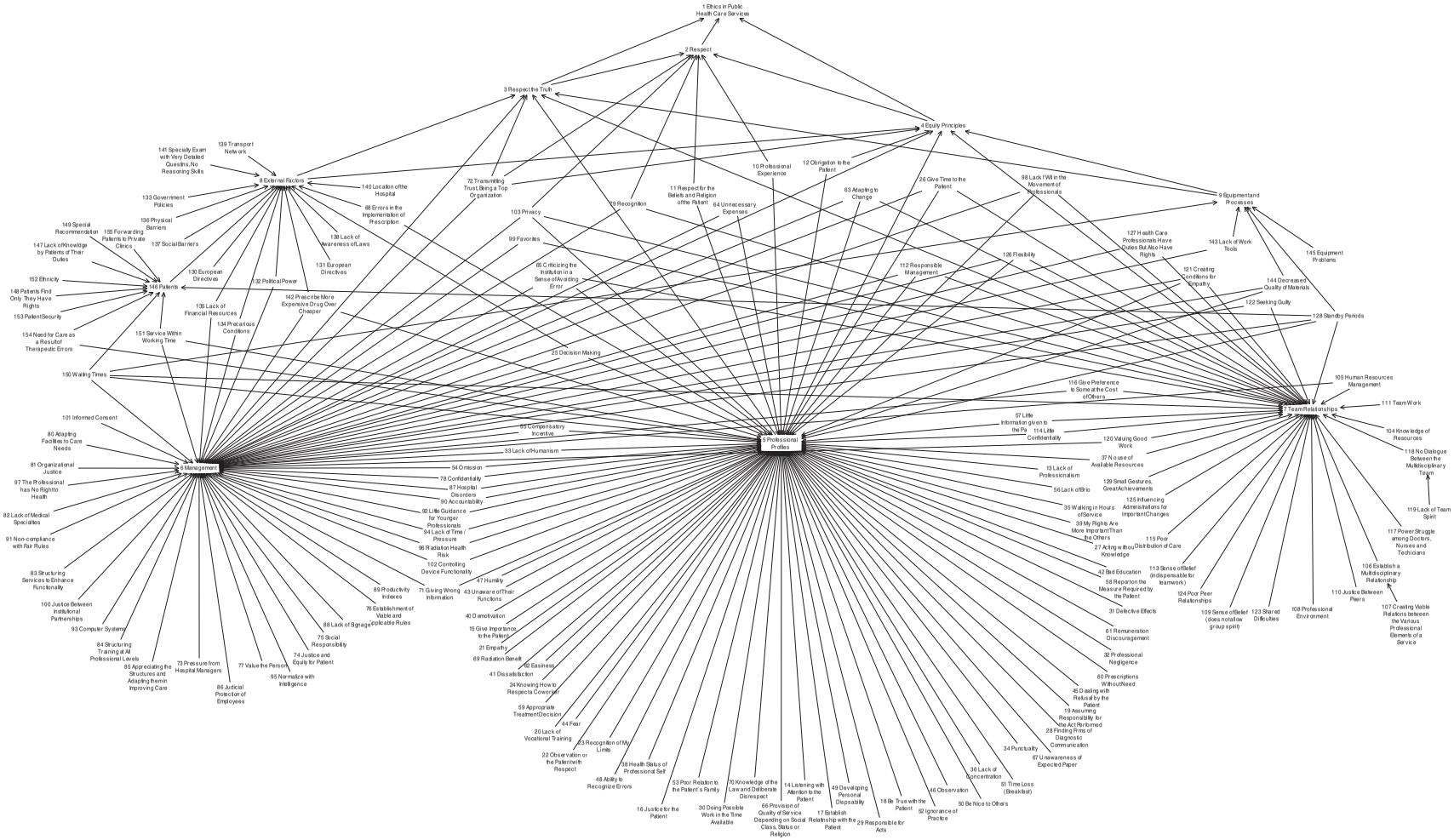


**FIGURE 2** Cognitive map of determinants of ethics in public healthcare services

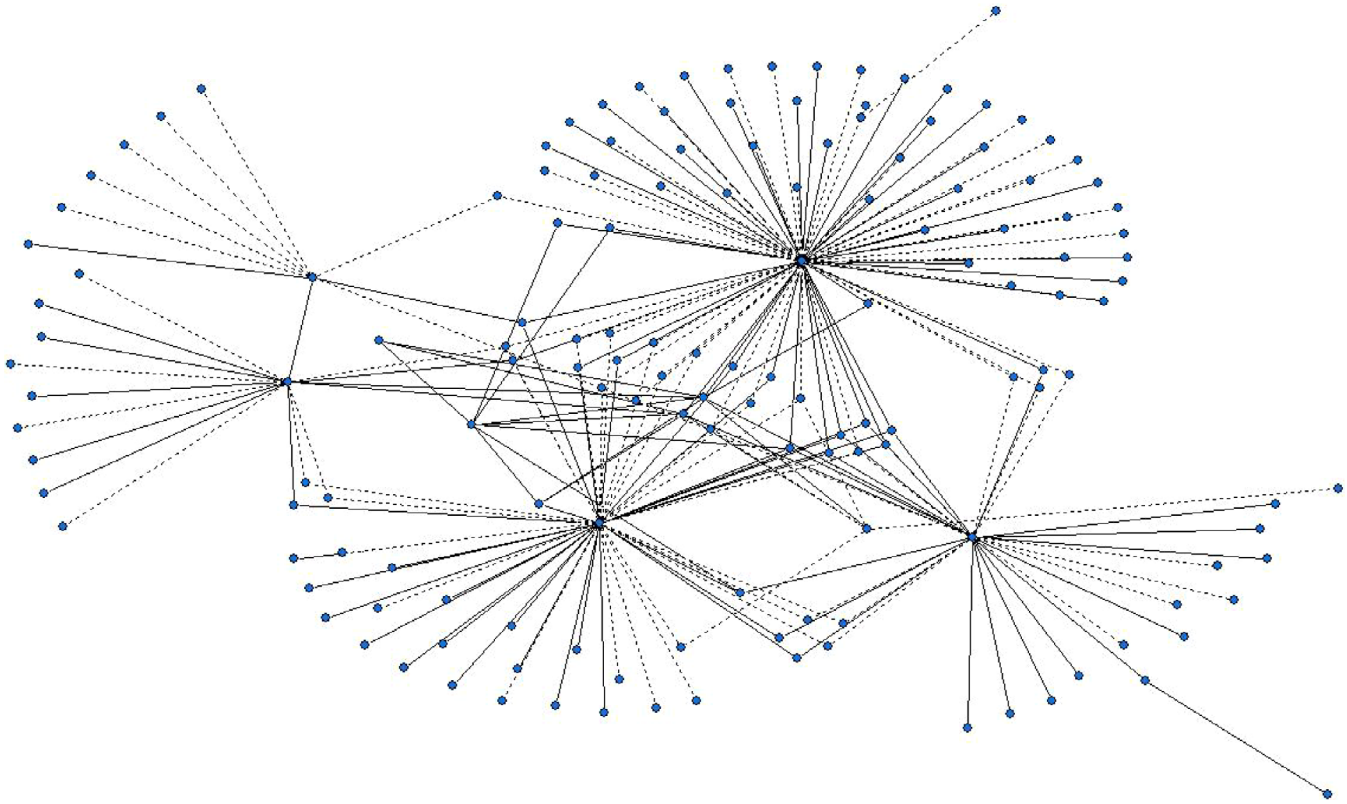

**FIGURE 3** Fuzzy cognitive map (FCM) of determinants of ethics in public healthcare services

**TABLE 2** Determinants' degree of centrality to ethics in public healthcare services

| Criteria/determinants | Outdegree | Indegree | Centrality |
|---|---|---|---|
| Professional profiles | 1.80 | 39.50 | 41.30 |
| Management | 1.80 | 32.50 | 34.30 |
| Team relationships | 0.90 | 15.70 | 16.60 |
| External factors | 0.60 | 8.50 | 9.10 |
| Equity principles | 2.00 | 5.00 | 7.00 |
| Respect | 1.00 | 5.80 | 6.80 |

## 4.3 | FCM development

Any basic cognitive structure can be transformed into an FCM by quantifying the intensity of the cause-and-effect relationships. As pointed out by Kosko (1986), the attribution of a value to causal relations (i.e., fuzzy quantification) allows researchers to construct more realistic and dynamic evaluation systems. According to Carvalho (2013), cause-and-effect relationships are the most common type of relationship between criteria.

In the present study, the panel of decision makers was asked to identify a degree of intensity for each relationship—represented by arrows in the cognitive map—during the second work session. The degree of intensity was based on the interval [−1, 1], with the interval [−1, 0[ being attributed to the cause-and-effect relationships identified as negative, and the interval ]0, 1] being ascribed to positive cause-and-effect relationships. The value assigned represents the degree of influence the causal concept has on the effect concept. The intensities of the cause-and-effect relationships were defined through dialogue and collective negotiation between the decision makers, which are key parts of this process since the intensity of each relationship needs to be determined by consensus.

After assigning degrees of intensity to the cause-and-effect relationships, an FCM could be constructed using the *FCMapper* (www.fcmappers.net) and *Pajek* (mrvar.fdv.uni-lj.si/pajek) software packages. To simplify Figure 3, all labels have been removed, but the complete version of the cognitive structure developed containing all specifications is available upon request. Carvalho (2013) suggests that, after an FCM is constructed, it can be used to model and simulate the behavior of the evaluation system.

## 4.4 | Static and dynamic analyses of results

According to Tsadiras (2008), FCM-based analysis identifies the factors with the greatest impact. This approach also predicts possible scenarios by varying the criteria or the degrees of intensity/importance for the decision problem under study. Therefore, researchers can analyze FCMs both statically and dynamically (Carlucci et al., 2018; Ferreira, 2016).

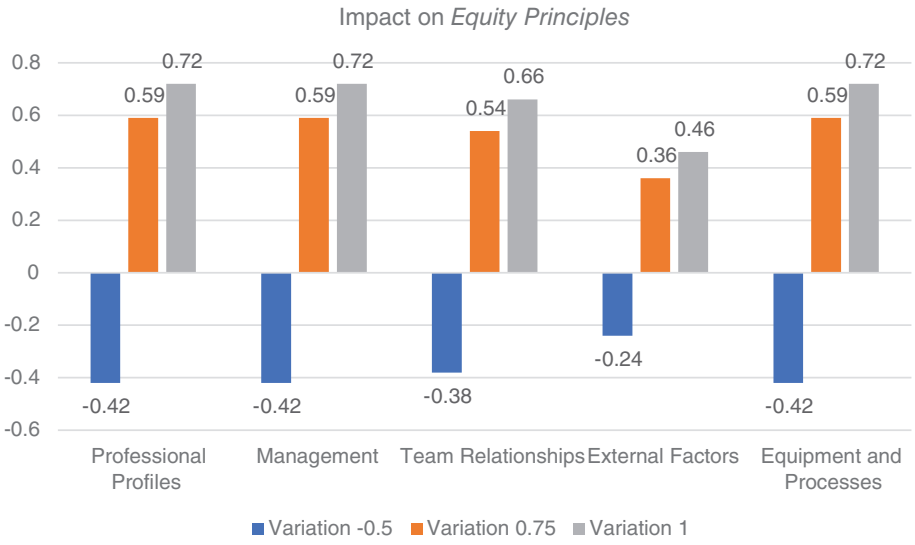


**FIGURE 4** Impact of cluster variations on *equity principles*

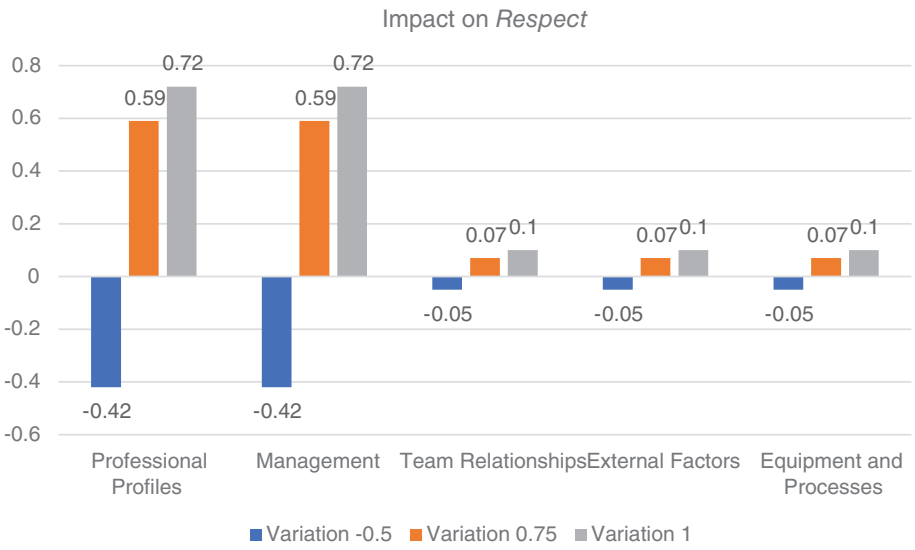


**FIGURE 5** Impact of cluster variations on *Respect*

### 4.4.1 | Static analysis

In static analysis, intensity values are not changed so that the degree of centrality of a criterion can be analyzed. Centrality is the indicator that results from adding up the weights of degrees of intensity for causality relationships between the criteria under study (i.e., outdegree and indegree) (Misthos, Messaris, Damigos, & Menegaki, 2017). Azevedo and Ferreira (2019) assert that centrality indicates the degree of importance of a criterion in the system represented by the FCM, so centrality is one of the most important indicators in this type of analysis. The greater the centrality of a criterion, the greater the importance it has. Table 2 presents the criteria or determinants that the panel of experts agreed are more important in NHS ethical practices.

The most central criteria defined by the decision makers are *professional profiles* (41.30), *management* (34.30), and *team relationships* (16.60). The criteria designated as *external factors* (9.10), *equity principles* (7.00), and *respect* (6.80) were, in descending order of importance, given significantly lesser centrality than the criteria at the top of the hierarchy. These results are consistent with the existing literature (e.g., Emanuel, 2000; Nunes, 2017; Pinto, 2012; Tepper, 2017; Werhane & Rorty, 2000). However, the expert panel identified other significant factors—in addition to the determinants corroborating the existing literature—that influence analyses of NHS ethical practices (cf. Figure 2).

### 4.4.2 | Dynamic analysis

Dynamic analyses of FCMs focus on evaluating system behaviors when the cause-and-effect relationships between concepts are changed. This type of analysis allows for the assessment of different scenarios (Yaman & Polat, 2009). The present study used the *Mental Modeller* software (www.mentalmodeler.org) to create "what-if" scenarios and thus observe the impact of variations on

**TABLE 3** Impact of criterion variations on *professional profiles* cluster

| Determinant | Degree of intensity | −0.50 variation | 0.75 variation | 1.00 variation |
|---|---|---|---|---|
| Lack of professionalism | −1.0 | 0.46 | −0.64 | −0.76 |
| Lack of vocational training | −0.5 | 0.24 | −0.36 | −0.46 |
| Relationships established with users | 0.8 | −0.38 | 0.54 | 0.66 |
| Responsibility taken for acts | 1.0 | −0.46 | 0.64 | 0.76 |

**TABLE 4** Impact of criterion variations on *management* cluster

| Determinant | Degree of intensity | −0.50 variation | 0.75 variation | 1.00 variation |
|---|---|---|---|---|
| Pressure from hospital managers | −0.1 | 0.05 | −0.07 | −0.1 |
| Organizational justice | 1.0 | −0.46 | 0.64 | 0.76 |
| Establishment of viable and applicable rules | 0.9 | −0.42 | 0.59 | 0.72 |
| Non-compliance with fair rules | −0.2 | 0.10 | −0.15 | −0.20 |

**TABLE 5** Impact of criterion variations on *team relationships* cluster

| Determinant | Degree of intensity | −0.50 variation | 0.75 variation | 1.00 variation |
|---|---|---|---|---|
| Poor distribution of care | −0.2 | 0.1 | −0.15 | −0.20 |
| Shared difficulties | 0.8 | −0.38 | 0.54 | 0.66 |
| Poor peer relationships | −0.1 | 0.05 | −0.07 | −0.10 |
| Professional environment | 0.7 | −0.34 | 0.48 | 0.60 |

**TABLE 6** Impact of criterion variation on *external factors* cluster

| Determinant | Degree of intensity | −0.50 variation | 0.75 variation | 1.00 variation |
|---|---|---|---|---|
| European directives | 0.9 | −0.42 | 0.59 | 0.72 |
| Social barriers | 0.6 | −0.29 | 0.42 | 0.54 |
| Lack of awareness of laws | −0.1 | 0.05 | −0.07 | −0.10 |
| Political power | 1 | −0.46 | 0.64 | 0.76 |

**TABLE 7** Impact of criterion variations on *equipment and processes* cluster

| Determinant | Degree of intensity | −0.50 variation | 0.75 variation | 1.00 variation |
|---|---|---|---|---|
| Equipment problems | −0.1 | 0.05 | −0.07 | −0.10 |
| Lack of work tools | −0.1 | 0.05 | −0.07 | −0.10 |
| Decreased quality of materials | −0.1 | 0.05 | −0.07 | −0.10 |
| Standby periods | −0.2 | 0.10 | −0.15 | −0.20 |

the evaluation system. The dynamic analysis had two phases: (a) at the cluster level (i.e., inter-cluster), observing the impact on the *equity principles* and *respect* criteria; and (b) at the intra-cluster level, analyzing the effects of variations in the criteria within each cluster.

*Dynamic analysis of clusters*

In the cluster analysis (i.e., inter-cluster), the impact of each cluster on two of the most strategic criteria—that is, *equity principles* and *respect*—was analyzed. In the decision makers' opinion, these are concepts linked to all clusters (i.e., *Professional Profiles*, *Management*, *Team Relationships*, *External Factors*, and *Equipment and Processes*). For this purpose, singular variations of −0.50, 0.75, and 1.00 were applied to each cluster to observe the effects on the core criteria (i.e., *equity principles* and *respect*). Figures 4 and 5 show the results caused by these variations.

The inter-cluster analysis identified which clusters cause more oscillations in the system. With a change of 0.75 and 1.00, the

determinants of *Professional Profiles* and *Management* had the same impact of 0.59 and 0.72, respectively, on *equity principles* and *respect*. This means that the two clusters of determinants increase the importance of the latter criteria in NHS ethical practices, supporting the conclusion that, the greater the strength of these clusters, the greater will be the valorization of ethical practices in NHS.

*Dynamic analysis at intra-cluster level*

In the dynamic intra-cluster analysis, four criteria (or determinants) of each cluster were randomly selected by the panel members and subjected to variations of −0.50, 0.75, and 1.00, as was done in the inter-cluster analysis. This step in the evaluation analyzed the impact of variations in each criterion on their respective cluster. Since the variation was equal for all criteria, the greater the weight (i.e., intensity) of the causal relationship, the greater the impact is on the cluster in question. Tables 3 to 7 summarize the impact of variations in the criteria within clusters (i.e., *Professional Profiles*, *Management*, *Team Relationships*, *External Factors*, and *Equipment and Processes*).

These results support the conclusion that the most important determinants of ethical practices in the public healthcare sector are the *Professional Profiles*, *Management*, and *Team Relationships* clusters. The significance of the determinants (or criteria) of these clusters is based on the decision makers' suggestions integrated into the FCM and derived from the indicators of centrality previously presented and analyzed.

The *Professional Profiles* cluster—with a degree of centrality of 41.30—describes health professionals' ideal set of characteristics, including the ability to assume responsibility for the positive impacts of their acts and the negative impact of a lack of professionalism. The interpersonal skills of these healthcare providers are also important, namely, their ability to develop relationships with users. *Management* is a cluster whose main criteria includes organizational justice and governance capability in terms of establishing viable and applicable rules. This cluster takes second place as a determinant of good ethical practices in NHS, with a centrality degree of 34.30 points. The *Team Relationships* cluster encompasses fundamental variables such as shared difficulties and professional environment, which are among the most significant determinants in this cluster, and occupies third place in terms of centrality with 16.60 points.

The information extracted from the inter-cluster and intra-cluster analyses facilitates, in this decision-making context, first, the identification of the most important criteria in the evaluation system. Second, the results allow for an examination of the effects that conjugations of variations (i.e., the creation of scenarios) have on the decision problem. Last, the information extracted can be used to justify improvements in the proposed evaluation system. However, the FCM has limitations that should be considered when future research on this topic is conducted.

## 4.5 | Validation, limitations, and recommendations

The FCM was constructed and validated to analyze the dynamics of NHS ethical practices based on input from a panel of professionals with knowledge and experience in relevant areas. Fuzzy cognitive mapping extracted the decision makers' knowledge through a systematic analysis that enabled a better understanding of the decision problem, as well as important conclusions. The panel members—as a group—expressed satisfaction with the results. Nonetheless, a validation session with a neutral, external entity was considered necessary to facilitate further discussion of the importance and practical applicability of the evaluation system, and generate recommendations for improvements.

This last session was held with the chairperson of the board of directors of S. Francisco Xavier Hospital in Lisbon, Portugal, for approximately 1 hr. The first objective was to present the study and its results succinctly. The second was to provide a brief description of the methodological framework and the advantages it offers to assessments of ethical healthcare practices. The third objective was to obtain feedback regarding the use of fuzzy cognitive mapping in the specific research context, while the fourth was to discuss the results. The last objective was to analyze the practical applicability of the proposed model, as well as its advantages and disadvantages compared to other commonly used evaluation systems.

To follow this plan, the session started with a brief presentation of the techniques used. The interviewee quickly realized that the evaluation system was based on the experts' points of view, values, and experiences, which increased the degree of subjectivity. The interviewer explained that, given the constructivist epistemological stance of the study and respective theoretical framework, the methodologies used are process-focused, so adjustments can be made to the system at any time to improve the results and reduce their subjectivity. The interviewee's response was that "*it is an interesting method for studying ethical practices in the NHS, including a series of underlying dimensions and factors*" (in the interviewee's words).

The chairperson interviewed also mentioned that the large number of evaluation criteria identified in the group cognitive map was remarkable, reinforcing this person's perception that cognitive mapping reduces the criteria omitted in the decision-making process. The interviewee also asserted that this approach provides a fuller understanding of the cause-and-effect relationships between the identified criteria.

This chairperson further offered two major recommendations. First, the findings could be strengthened by choosing a more diversified panel of experts. Second, the interviewee recommended including comparative analyses. According to this expert, the researchers "*need to perform more analyses and more case studies to reduce subjectivity in the results*" (also in her words). This suggestion further confirmed the process-oriented nature of the framework developed, as well as its complementary—rather than substitutive—nature in terms of other evaluation models. Overall, the interviewee supported the outcomes obtained and plans for a practical application of the proposed system to S. Francisco Xavier Hospital.

Despite the results achieved, the application of the adopted methodology has limitations. The information used as the basis for the model was drawn from the decision makers' experience and knowledge, and thus the results are context-dependent. This means that extrapolation of the present findings must be done with all due caution (Ferreira & Jalali, 2015). However, by including the decision makers' beliefs and values, this tool integrated objective and

subjective factors, and the results are more realistic. From a constructivist perspective, ignoring subjective factors reduces the potential support provided to decision makers (Ferreira, 2013). Furthermore, the results can always be updated and/or corrected.

In addition to the advantage of extracting information, the most significant contribution of this methodology is the ongoing learning process and negotiation required, which, in turn, lead to the construction of more complete FCMs. According to Gray, Zanre, and Gray (2013), this creation process stimulates decision makers' learning by bringing them into contact with different perspectives. The present study confirmed the potential of the methodology by applying it in an analysis of NHS ethical practices.

## 5 | CONCLUSION

Given that national healthcare services have a tremendous impact on society, having mechanisms that accurately assess their ethical practices is quite important. A dynamic evaluation model is key to evaluating ethical practices in the healthcare sector and to supporting its decision-making processes while promoting continuous improvement. The main objective of this study was thus to use fuzzy cognitive mapping to examine the impacts of ethical practices on the health sector.

The rationale for using an FCM to structure the decision problem under analysis can be subdivided into four areas. First, this tool can help identify a larger number of analytical variables (i.e., multidisciplinary analysis). Second, FCMs can highlight cause-and-effect relationships between the identified criteria, which contributes to a deeper understanding of the dynamics and effects of ethical healthcare practices. Third, this tool facilitates the integration of subjective variables drawn from decision makers' beliefs, values, and experiences. Last, FCMs provide a framework that supports decision-making processes by simulating various scenarios. Furthermore, this type of cognitive mapping promotes group dialogues and discussions because it is based on human knowledge and thus on the decision makers' subjective beliefs about the problem under analysis. The use of fuzzy cognitive mapping techniques supports decision-making processes and, when adapted to specific research contexts, FCMs can be applied in a variety of areas.

In this study, the results support the conclusion that the most important variables defining NHS ethical practices are: (a) *professional profiles*; (b) *management*; (c) *team relationships*; (d) *external factors*; (e) *equity principles*; and (f) *respect*. No prior studies using fuzzy cognitive mapping in this study context were found in the literature. Notably, the present approach is based on complementarity rather than a desire to substitute the available evaluation models. Thus, this article could be important on a theoretical and practical level.

While the findings are context-specific, they could be an important starting point for other researchers and practitioners seeking to analyze NHS ethical practices, and the findings should complement previous studies in this field. From a methodological perspective, the present study makes two contributions. Its primary value relates to the techniques used, which appear to be innovative in this research context. The second contribution arises from the description of the proposed process, which permits replications in other contexts and/or with different groups of experts because of the process-oriented nature of the framework (Bell & Morse, 2013; Ormerod, 2013).

Due to the idiosyncratic nature of the present approach, any generalizations or extrapolations will need to be analyzed and adapted with all due caution. As mentioned previously, the objective of this study was not to obtain the ideal model but instead to foster the development of new approaches and develop an FCM that can improve NHS decision-making processes. Thus, future research along the same lines may want to consider other techniques capable of modelling decision makers' interactions and preference structures (e.g., see Belton & Stewart, 2002). Another option would be to conduct comparative studies involving different techniques. Although methodological comparisons are clearly important, and they should be encouraged in further research, the complementary stance of the present study needs to be highlighted once again. The objective was not to substitute previous methods or models but rather to augment them. Therefore, from a methodological point of view, more interesting results could be obtained by applying the proposed approach to different contexts and topics. Any contributions that increase the empirical robustness of the present research and provide further advances in this field will be welcome additions to the literature.

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### REFERENCES

Ackermann, F. (2012). Problem structuring methods 'in the dock': Arguing the case for soft OR. *European Journal of Operational Research*, *219*(3), 652–658.

Ackermann, F., & Eden, C. (2001). SODA – Journey making and mapping in practice. In J. Rosenhead & J. Mingers (Eds.), *Rational analysis for a problematic world revisited: Problem structuring methods for complexity, uncertainty and conflict* (pp. 43–60). Chichester, England: John Wiley & Sons.

Azevedo, A., & Ferreira, F. (2019). Analyzing the dynamics behind ethical banking practices using fuzzy cognitive mapping. *Operational Research*, *19*(3), 679–700.

Beauchamp, T., & Childress, J. (1979). *Principles of biomedical ethics*. New York, NY: Oxford University Press.

Beierle, T., & Cayford, J. (2002). *Democracy in practice: Public participation in environmental decisions*. Washington, DC: RFF Press.

Bell, S., & Morse, S. (2013). Groups and facilitators within problem structuring processes. *Journal of the Operational Research Society*, *64*(7), 959–972.

Belton, V., Ackermann, F., & Shepherd, I. (1997). Integrated support from problem structuring through to alternative evaluating using COPE and V.I.S.A. *Journal of Multi-Criteria Decision Analysis*, *6*(3), 115–130.

Belton, V., & Stewart, T. (2002). *Multiple criteria decision analysis: An integrated approach*. Dordrecht, the Netherlands: Kluwer Academic.

Branco, J., Ferreira, F., Meidutė-Kavaliauskienė, I., Banaitis, A., & Falcão, P. (2019). Analysing determinants of small and medium-sized enterprise resilience using fuzzy cognitive mapping. *Journal of Multi-Criteria Decision Analysis*, *16*(5/6), 252–264.

Campbell, A. (2003). The virtues (and vices) of the four principles. *Journal of Medical Ethics*, *29*(5), 292–296.

Carayannis, E., Ferreira, J., Jalali, M., & Ferreira, F. (2018). MCDA in knowledge-based economies: Methodological developments and real world applications. *Technological Forecasting and Social Change*, *131*, 1–3.

Carlucci, D., Ferreira, F., Schiuma, G., Jalali, M., & António, N. (2018). A holistic conception of sustainable banking: Adding value with fuzzy cognitive mapping. *Technological and Economic Development of Economy*, *24*(4), 1303–1322.

Carlucci, D., Schiuma, G., Gavrilova, T., & Linzalone, R. (2013). A fuzzy cognitive map based approach to disclose value creation dynamics of ABIs. In *Proceedings of the 8th international forum on knowledge asset dynamics (IFKAD-2013)* (pp. 207–219). Zagreb, Croatia: International Forum on Knowledge Asset Dynamics.

Carrol, A. (1991). The pyramid of corporate social responsibility: Toward the moral management of organizational stakeholders. *Business Horizons*, *34*(4), 39–48.

Carvalho, J. (2013). On the semantics and the use of fuzzy cognitive maps and dynamic cognitive maps in social sciences. *Fuzzy Sets and Systems*, *214*, 6–19.

Eden, C. (2004). Analyzing cognitive maps to help structure issues or problems. *European Journal of Operational Research*, *159*(3), 673–686.

Eden, C., & Ackermann, F. (2004). Cognitive mapping expert views for policy analysis in the public sector. *European Journal of Operational Research*, *152*(3), 615–630.

Emanuel, L. (2000). Ethics and the structures of heath care. *Cambridge Quarterly of Health Care Ethics*, *9*(2), 151–168.

Ferreira, F. (2013). Measuring trade-offs among criteria in a balanced scorecard framework: Possible contributions from the multiple criteria decision analysis research field. *Journal of Business Economics and Management*, *14*(3), 433–447.

Ferreira, F. (2016). Are you pleased with your neighborhood? A fuzzy cognitive mapping-based approach for measuring residential neighborhood satisfaction in urban communities. *International Journal of Strategic Property Management*, *20*(2), 130–141.

Ferreira, F., & Jalali, M. (2015). Identifying key determinants of housing sales and time-on-the-market (TOM) using fuzzy cognitive mapping. *International Journal of Strategic Property Management*, *19*(3), 235–244.

Ferreira, F., Jalali, M., & Ferreira, J. (2016). Experience-focused thinking and cognitive mapping in ethical banking practices: From practical intuition to theory. *Journal of Business Research*, *69*(11), 4953–4958.

Ferreira, F., Jalali, M., Meidutė-Kavaliauskienė, I., & Viana, B. (2015). A metacognitive decision making based framework for bank customer loyalty measurement and management. *Technological and Economic Development of Economy*, *21*(2), 280–300.

Ferreira, F., Meidutė-Kavaliauskienė, I., Zavadskas, E., Jalali, M., & Catarino, S. (2019). A judgment-based risk assessment framework for consumer loans. *International Journal of Information Technology & Decision Making*, *18*(1), 7–33.

Ferreira, F., Spahr, R., Santos, S., & Rodrigues, P. (2012). A multiple criteria framework to evaluate bank branch potential attractiveness. *International Journal of Strategic Property Management*, *16*(3), 254–276.

Fragkiadakis, G., Doumpos, M., Zopounidis, C., & Germain, C. (2016). Operational and economic efficiency analysis of public hospitals in Greece. *Annals of Operations Research*, *247*(2), 787–806.

Froelich, W., & Salmeron, J. (2017). Advances in fuzzy cognitive maps theory. *Neurocomputing*, *232*, 1–2.

George, A. (2016). Research ethics. *Medicine*, *44*(10), 615–618.

Glykas, M. (2013). Fuzzy cognitive strategic maps in business process performance measurement. *Expert Systems with Applications*, *40*(1), 1–40.

Gray, S., Zanre, E., & Gray, S. (2013). Fuzzy cognitive maps as representations of mental models and group beliefs. In E. Papageorgiou (Ed.), *Fuzzy cognitive maps for applied sciences and engineering* (pp. 29–48). Berlin, Heidelberg: Springer.

Grigoroudis, E., Orfanoudaki, E., & Zopounidis, C. (2012). Strategic performance measurement in a healthcare organisation: A multiple criteria approach based on balanced scorecard. *Omega – The International Journal of Management Science*, *40*(1), 104–119.

Groumpos, P. (2015). Modelling business and management systems using fuzzy cognitive maps: A critical overview. *IFAC – PapersOnLine*, *48*(24), 207–212.

Harris, J. (2003). In praise of unprincipled ethics. *Journal of Medical Ethics*, *29*(5), 303–306.

Hester, P. (2015). Analyzing stakeholders using fuzzy cognitive mapping. *Procedia Computer Science*, *61*, 92–97.

Howick, S., & Eden, C. (2011). Supporting strategic conversations: The significance of a quantitative model building process. *Journal of the Operational Research Society*, *62*(5), 868–878.

Kang, B., Deng, Y., Sadiq, R., & Mahadevan, S. (2012). Evidential cognitive maps. *Knowledge-Based Systems*, *35*(15), 77–86.

Kardaras, D., & Mentzas, G. (1997). Using fuzzy cognitive maps to model and analyze business performance assessment. In *Proceedings of the international conference on advances in industrial engineering applications and practice II* (pp. 63–68). California: Goodreads.

Knox, J. (2014). The 4C model: A reflective tool for the analysis of ethical cases at the neonatal intensive-care unit. *Clinical Ethics*, *9*(4), 120–126.

Kosko, B. (1986). Fuzzy cognitive maps. *International Journal of Man-Machine Studies*, *24*(1), 65–75.

Lawson, A. (2011). What is medical ethics? *Trends in Anesthesia and Critical Care*, *1*(1), 3–6.

Lousada, A., Ferreira, F., Meidutė-Kavaliauskienė, I., Spahr, R., Sunderman, M., & Pereira, L. (2021). A sociotechnical approach to causes of urban blight using fuzzy cognitive mapping and system dynamics. *Cities – The International Journal of Urban Policy and Planning*, *108*, 1–13.

Martins, S., Ferreira, F., Ferreira, J., & Marques, C. (2020). An artificial-intelligence-based method for assessing service quality: Insights from the prosthodontics sector. *Journal of Service Management*, *31*(2), 291–312.

Marttunen, M., Lienert, J., & Belton, V. (2017). Structuring problems for multi-criteria decision analysis in practice: A literature review of method combinations. *European Journal of Operational Research*, *263*(1), 1–17.

McDevitt, R., Giapponi, C., & Tromley, C. (2007). A model of ethical decision making: The integration of process and content. *Journal of Business Ethics*, *73*(2), 219–229.

McGovern, C. (2016). Medical ethics: Principles of medical ethics. *Encyclopedia of Forensic and Legal Medicine*, *3*, 330–334.

Midgley, G., Cavana, R., Brocklesby, J., Foote, J., Woos, D., & Ahuriri-Driscoll, A. (2013). Towards a new framework for evaluating systemic problem structuring methods. *European Journal of Operational Research*, *229*(1), 143–154.

Mingers, J., & Rosenhead, J. (2004). Problem structuring methods in action. *European Journal of Operational Research*, *152*(3), 530–554.

Misthos, L., Messaris, G., Damigos, D., & Menegaki, M. (2017). Exploring the perceived intrusion of mining into the landscape using the fuzzy cognitive mapping approach. *Ecological Engineering*, *101*, 60–74.

Molterer, K., Hoyer, P., & Steyaert, C. (2020). A practical ethics of care: Tinkering with different 'goods' in residential nursing homes. *Journal of Business Ethics*, *165*, 95–111.

Nunes, R. (2017). Ethics in science. *Porto Biomedical Journal*, *2*(4), 97–98.

Ormerod, R. (2013). Logic and rationality in OR interventions: An examination in the light of the 'critical rationalist' approach. *Journal of the Operational Research Society*, *64*(4), 469–487.

Papageorgiou, E., Roo, J., Huszka, C., & Colaert, D. (2012). Formalization of treatment guidelines using fuzzy cognitive maps and semantic web tools. *Journal of Biomedical Informatics*, *45*(1), 45–60.

Papageorgiou, E., & Salmeron, J. (2013). A review of fuzzy cognitive maps research during the last decade. *IEEE Transactions on Fuzzy Systems*, *21*(1), 66–79.

Pasricha, P., Singh, B., & Verma, P. (2018). Ethical leadership, organic organizational cultures and corporate social responsibility: An empirical study in social enterprises. *Journal of Business Ethics*, *151*(4), 941–958.

Pereira, V., Ferreira, F., & Chang, H. (2019). A constructivist multiple criteria framework for mortgage risk analysis. *INFOR: Information Systems and Operational Research*, *57*(3), 361–378.

Pinto, V. (2012). *Ethical fundamentals in health priorities*. Lisbon, Portugal: National Council of Ethics for Life Sciences.

Pires, A., Ferreira, F., Jalali, M., & Chang, H. (2018). Barriers to real estate investments for residential rental purposes: Mapping out the problem. *International Journal of Strategic Property Management*, *22*(3), 168–178.

Rehbock, T. (2011). Limits of autonomy in biomedical ethics? Conceptual clarifications. *Cambridge Quarterly of Health Care Ethics*, *20*(4), 524–532.

Ribeiro, M., Ferreira, F., Jalali, M., & Meidutė-Kavaliauskienė, I. (2017). A fuzzy knowledge-based framework for risk assessment of residential real estate investments. *Technological and Economic Development of Economy*, *23*(1), 140–156.

Rosenhead, J. (2006). Past, present and future of problem structuring methods. *European Journal of Operational Research*, *57*(7), 759–765.

Ross, W. (1930). *The right and the good* [reprinted with an introduction by Philip Stratton-Lake, 2002]. Oxford, England: Oxford University Press.

Salmeron, J. (2012). Fuzzy cognitive maps for artificial emotions forecasting. *Applied Soft Computing*, *12*(12), 3704–3710.

Santos, F., Ferreira, F., & Meidutė-Kavaliauskienė, I. (2018). Perceived key determinants of payment instrument usage: A fuzzy cognitive mapping-based approach. *Technological and Economic Development of Economy*, *24*(3), 950–968.

Schlairet, M., Kiser, K., & Norris, S. (2012). Clinical ethics support services: An evolving model. *Nurse Outlook*, *60*(5), 309–315.

Schumann, J., & Alfandre, D. (2008). Clinical ethical decision making: The four topics approach. *Seminars in Medical Practice*, *11*, 36–42.

Stylios, C., & Groumpos, P. (2007). The challenge of modeling supervisory systems using fuzzy cognitive maps. *Journal of Intelligent Manufacturing*, *9*(4), 339–345.

Tegarden, D., & Sheetz, S. (2003). Group cognitive mapping: A methodology and system for capturing and evaluating managerial and organizational cognition. *Omega – The International Journal of Management Science*, *31*(2), 113–125.

Tepper, J. (2017). Ethics in clinical care. *International Journal of Radiation Oncology Biology Physics*, *99*(2), 250–254.

Tsadiras, A. (2008). Comparing the inference capabilities of binary, trivalent and sigmoid fuzzy cognitive maps. *Information Sciences*, *178*(20), 3880–3894.

Vaz de Almeida, M., Ferreira, J., & Ferreira, F. (2019). Developing a multicriteria decision support system for evaluating knowledge transfer by higher education institutions. *Knowledge Management Research & Practice*, *17*(4), 358–372.

Vidal, R. (2004). Guest editor's introduction. *European Journal of Operational Research*, *152*(3), 529.

Wagner, J., & Dahnke, M. (2015). Nursing ethics and disaster triage: Applying utilitarian theory. *Journal of Emergency Nursing*, *41*(4), 300–306.

Werhane, P., & Rorty, M. (2000). Organizational ethics in health care. *Cambridge Quarterly of Health Care Ethics*, *9*(2), 145–146.

Winkler, E., & Gruen, R. (2005). First principle: Substantive ethics for health care organizations. *Journal of Health Care Management*, *50*(2), 109–119.

Wu, M., Liao, C., Chiu, W., Lin, C., & Yang, C. (2011). Can we accredit hospital ethics? A tentative proposal. *Journal of Medical Ethics*, *37*(8), 493–497.

Yaman, D., & Polat, S. (2009). A fuzzy cognitive map approach for effect-based operations: An illustrative case. *Information Sciences*, *179*(4), 382–403.

Zhang, L., Chettupuzha, A., Chen, H., Wu, X., & AbouRizk, S. (2017). Fuzzy cognitive maps enabled root cause analysis in complex projects. *Applied Soft Computing*, *57*, 235–249.

Ziv, G., Watson, E., Young, D., Howard, D., Larcom, S., & Tanentzap, A. (2018). The potential impact of Brexit on the energy, water and food nexus in the UK: A fuzzy cognitive mapping approach. *Applied Energy*, *210*, 487–498.

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