Expert Systems With Applications 45 (2016) 223–233

Contents lists available at ScienceDirect

Expert Systems With Applications

journal homepage: www.elsevier.com/locate/eswa

Decision model for complex group argumentation

Junyi Chai*, Eric W.T. Ngai

Department of Management and Marketing, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong

ARTICLE INFO

Keywords:
Decision making
Group argumentation
Supplier selection
Supply chain

ABSTRACT

This paper reports on a decision-making model that can be used for group argumentation when decisions contain twofold complexities: the problem itself and the people (i.e., the decision makers). Related studies have been well documented in literature; however, research on the group mechanism remains limited with regard to two aspects: (1) the complexities of problems and people and (2) the interaction manners of opinions derived from people. In this study, we develop a mechanism called the complex group argumentation (CGA) framework for group decision making. This solution applies the classic methodology of system designs, that is, qualitative-to-quantitative metasynthesis, and contains two core processes, namely, complexity resolution and group argumentation. From a practical perspective, we evaluate the performance of the CGA framework in the context of supplier selection (SS). Results show that our approach can satisfy the requirements of practical SS, while simultaneously coping with the disadvantages of real-world complex GDM. The results of this research can inspire studies on group argumentation in academics and provide proposals for mechanisms on the development of group support systems in the industrial community.

1. Introduction

The decision making (DM) methodology is under the paradigm of actions that includes ranking, sorting, and selecting among a number of prepared alternatives to best achieve predefined objectives. When the objectives are specified as multiple dimensions, DM is known as multiple criteria decision making (MCDM) (Wallenius et al., 2008). The DM process considerably involves human factors, which produces the sub-fields of individual DM and group DM (GDM). Keeney (2013) defined group decisions as "decisions where a group of two or more individuals must collectively select an alternative from a set of two or more alternatives that best satisfies the group's goal, and no individual has veto power." A group consists of individuals with correlative talents who are committed to a common purpose, a specific goal, and a similar working approach; accountability is evenly distributed among the members of a group. However, individuals are naturally inclined to satisfy their own objectives first before those of other individuals or the group. The experiment of Keck, Diecidue, and Budescu (2014) showed that groups were more likely to make ambiguity-neutral decision than individuals. An important problem in GDM is to integrate multifarious opinions, which requires the group argumentation process.

Supplier selection (SS) is a typical scenario in MCDM. Its strategic success is typically attributed to multiple individuals involved in DM processes. Ho, Dey, and Lockström (2011) suggested that stakeholders from both internal and external companies should be involved to obtain an unbiased deliberation of conflicting opinions. Chai and Ngai (2015) required stakeholders to be qualified and to possess sufficient competence and influence on the supply chain; in particular, they should be capable of considering of both horizontal and vertical dimensions. Considering stakeholders as group members, this study focuses on understanding two core issues: (1) determining qualified stakeholders as group members for evaluating the supplier process and (2) supporting argumentation or negotiation among individuals through a system approach in cases that involve multiple or even conflicting opinions of stakeholders. Essentially, these issues can be encapsulated into two core challenges in practical GDM: (1) the complexities of a problem itself and (2) the complexities of a group.

Group consensus in SS is highly important; however, the mechanism of group argumentation under complexities remains. In this study, we are concerned about the requirements for group argumentation strategies and will propose workable conceptual designs. The contributions of this study are summarized as follows. We propose a novel conceptual model called the complex group argumentation (CGA) framework. Two core units of this model are examined: (1) twofold complexity-resolution approaches (problem *decomposition* and group *screening*) and (2) group argumentation process and model. We recommend and use a classical methodology, namely, qualitative-to-quantitative metasynthesis (Qian, 1991; Qian, Yu, & Dai, 1990) for system designs. This methodology is capable

* Corresponding author. Tel.: +852 5138 0601.
E-mail addresses: donchaiam@gmail.com, don.chai@polyu.edu.hk (J. Chai), eric.ngai@polyu.edu.hk (E.W.T. Ngai).

http://dx.doi.org/10.1016/j.eswa.2015.09.051
0957-4174/

of handling complex systems that fit well with the situation being studied, that is, group process under complexities. This methodology has been proven to be effective in building the Chinese system framework "hall for workshop of metasynthetic engineering (HWME)" (Dai & Cao, 2002; Gu & Tang, 2005), but has not yet been implemented abroad. We consider our framework to be conceptually novel for academics. The established group models can be beneficial for both practitioners and academics, and are expected to be widely adapted and discussed in further studies.

The rest of this paper is organized as follows. Section 2 provides a literature review on decision and group argumentation. Section 3 elaborates on the resolution mechanisms for twofold complexities, which are the preliminary considerations of our framework. Section 4 presents the conceptual model of the CGA framework. Section 5 discusses the development of a group argumentation model and system process designs within the proposed framework. Section 6 evaluates our design and development in the SS context. Section 7 concludes the study.

2. Literature review on group decision and argumentation

2.1. Group decision making

Early landmark solutions for GDM were presented by Arrow (1951) and Keeney (1976). They attempted to examine the possibilities of aggregating the preferences of individuals into an ordinal (Arrow, 1951) or cardinal (Keeney, 1976) preference function of a group that can satisfy preset conditions. Dias and Sarabando (2012) developed a formulation to control the possibility of an individual exerting influence over a group. The formulation is similar to the non-dictatorship condition under the solutions of Arrow and Keeney. The judgment of an individual is typically made according to different types of logic and partition. Predd, Osherson, Kulkarni, and Poor (2008) developed a method to aggregate probabilistic forecasts from incoherent and abstaining group members. Schilling, Oeser, and Schaub (2007) captured the alignment of group members quantitatively using a before/after preference measurement design. In case of group members arguing against the set, utility, and values of DM, but must still agree on a decision, Rios and Rios Insua (2009) proposed to partition the set of non-dominated alternatives, and negotiating over these alternatives, in particular, using a guaranteeing Pareto optimality. Huang, Chang, Li, and Lin (2013) extended the intuitive additive weighting method for individual preference aggregation and referred to the dissimilarity of preference levels.

2.2. Supplier selection under three-track DM

Supplier selection (SS) plays a crucial role in sourcing strategies because of its overall influences.

The interest in this issue has been increasing considerably over the past years. Under the MCDM paradigm, popular literature surveys, such as those of Chai, Liu, and Ngai (2013), Ho, Xu, and Dey (2010), and Govindan, Rajendran, Sarkis, and Murugesan (2015), have been conducted in terms of technique employment, criteria establishment, structural decision, and sustainable development. We can compile these issues into three tracks: structural, semi-structural, and non-structural levels. Simon (1955, 1962) suggested that DM could be generally classified into non-structural and structural forms. He claimed that non-structural problems never emerged under this dichotomy, and thus, no past experience could be learned or applied to resolve issues. Related problem structures or conditions are typically too complex and require human intelligence such as intuitive observation and creative thinking.

The group argumentation process can emerge from three-track DM. In particular, the structural level requires well-organized decision tasks (Zigurs & Buckland, 1998), highly structured information, and clear criteria for evaluation. Typical studies on this subject include Awasthi, Chauhan, and Goyal (2010), Bai and Sarkis (2010), and Li and Zabinsky (2011). The semi-structural level is concerned with criteria establishment (Ho et al., 2011), relations among criteria (Chai & Liu, 2014), and company strategic orientations (Shen & Yu, 2009). Finally, the non-structural level covers the organizational and psychological factors of DM processes. This level focuses more on enterprise completive strategies (Gunasekaran & Ngai, 2005), psychological needs and IS adoption (Au, Ngai, & Cheng, 2008), supply chain risks (Kull & Talluri, 2008), company policies (Zhang & Chen, 2013), and the auction process (Chaturvedi, Beil, & Martinez-de-Albeniz, 2014; Jin et al. 2014). Structural-level DM aims to learn past experiences, techniques, and methods through motivated or integrated usage considering highly organized information and clear evaluation principles. Semi-structural and non-structural DM require both quantitative and qualitative analyses, frequent communication and discussion, and support mechanisms such as voting or scoring. This process, which is known as group argumentation (Bui et al. 1997; Espinasse, Picolet, & Chouraqui, 1997) or group negotiation (Ehtamo et al., 1999; Raiffa, 1982; Wang & Zionts, 2008), has been promoted and used in SS in literature (Cakravastia & Takahashi, 2004; Choudhury, Shankar, & Tiwari, 2006; Dudek & Stadtler, 2005).

2.3. Group argumentation

Argumentation theory was first examined by Dung (1995), who suggested that an argumentation system provided both a set of arguments and the manner in which they would interact with respect to the corresponding agent. Since then, group argumentation has been typically examined in terms of theoretical construction and expert/intelligence system. From a theoretical perspective, Sillince (1996) proposed an argumentation design and contract models for strategic organizational decision. He considered semi-autonomous groups and proposed an interaction paradigm that included argumentation domain, grammar, and procedures. Karacapilidis, Papadias, Gordon, and Voss (1997) presented a framework that supported rational and efficient DM when agents were members of a group. Ei-Shinnawy and Vinze (1998) argued that group composition in GDM had no effect on either group polarization or persuasive arguments. Zhang, Sun, and Chen (2005) considered the nature of decision task and provided an approach for generating and identifying these tasks in an organization. Atkinson and Bench-Capon (2007) provided a practical reasoning approach based on the presumptive justification of actions by instantiating an argument scheme. Coste-Marquis, Devred, Konieczny, Lagasquie-Schiex, and Marquis (2007) generated a framework based on Dung's argumentation system. Mercier (2011) considered the expert reasoning of argumentative theory from a psychological viewpoint. From a system perspective, Ramesh and Whinston (1994) argued that the group argumentation process in a decision support system (DSS) that consisted of three formalisms, namely, representation, gaming, and coordination; they proposed a framework of argumentative reasoning facilitation systems. De Moor and Aakhus (2006) extended traditional information system (IS) modeling approaches to a language-action perspective (LAP) and developed a LAP-based diagnostic method to support argumentation. Vetschera (2007) examined the preferences embedded into electronic negotiation support systems to reflect the behavior of negotiators and negotiation outcomes precisely via an empirical manner.

We discuss current literature from three aspects. First, from the aspect of decision theory, Keeney (2013) adopted a set of DM assumptions and indicated that group-expected utility can be a weighted sum of individual expected utilities. This general GDM model allows individuals to have different objectives, frames, and perspectives regarding the same problem. Second, from the aspect of psychology, Fisher and Keil (2014) found the existence of an illusion of argument justification. This finding explains the reason group