Preference Coalition Formation Scheme for Buyer Coalition Services with Bundles of Items

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ABSTRACT

Coalition stability is a major requirement in coalition formation. One important problem to achieve stability in n-person game theories is the assumption that the preference of each buyer is publicly known. The coalition is said to be stable if there are no objection by any subset of buyers according to their publicly known preferences. However, such assumption is often unrealistic in typical real-life situations. Individual buyers often have private preferences and make their decisions according to their own preferences instead. This study proposes a novel preference coalition formation scheme for buyer coalition services that attempts to consider private preference of individual buyers within the buyer coalition process. The theoretical foundations of the study are rooted in the fields of multi-criteria decision making, human practical reasoning, and n-person game theories, from which we design an appropriate scheme for our proposed buyer coalition framework with emphasis on private preferences of individual buyers. The authors validate their proposed scheme with simulation software developed to demonstrate results of a variety of practical situations.

INTRODUCTION

The study in buyer coalition service is receiving much attention as group buying has become popular recently. For example, n-person game theories provide an analysis of the potential coalitions that shall form as the resulting disbursements to the buyers (Kahan & Rapoport, 1984). Such theories usually concentrate on the examination of their stability or their fairness such as the core, the shapley value, and the bargain set and are often applied to buyer the analysis of buyer coalition services. However, these theories are based on assumption that each buyer’s preference is publicly known. For example, assume that three buyers, a, b, and c are considering to buy and share a bundled set of products. Their preferences are that each of them prefers to go in possible coalitions. In summary, their preferences are given by:

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• Buyer a’s preference:

\[
\{a, b\}, \text{ buying } \succ_a \{a, c\}, \text{ buying} >_a \{a, b, c\}, \text{ buying} >_a \{a\}, \text{ buying}
\]

• Buyer b’s preference:

\[
\{b, c\}, \text{ buying } \succ_b \{a, b\}, \text{ buying} >_b \{a, b, c\}, \text{ buying} >_b \{b\}, \text{ buying}
\]

• Buyer c’s preference:

\[
\{a, c\}, \text{ buying } \succ_c \{b, c\}, \text{ buying} >_c \{a, b, c\}, \text{ buying} >_c \{c\}, \text{ buying}
\]

This assumption has a drawback because it is in conflict with scenario which buyers often have to rely on their own private preference during the coalition’s formation process. There are many researches (Chan & Leung, 2011; He & Ioerger, 2005; Kraus, Shehory, & Taase, 2004; Kraus, Shehory, & Taase, 2003) that are not able to provide such publicly known preferences.

In this paper, we consider a coalition formed in a distributed system with central authority under an assumption that individual buyers have private preferences within the buyer coalition process and we target to provide a solution with a low complexity. The ELECTRE (ELimination and Choice Expressing REality) III method in multi-criterion decision making (MCDM) is combined with Belief-Desire-Intention (BDI) reasoning mechanism and n-person game theories first time in our scheme to provide practical stable solutions for such applications. The BDI model originates in the theory of human practical reasoning that of a manner of explaining future-directed intentions (Bratman, 1987), and is therefore very useful for determining feasible buyer coalition formation.

The major contribution of the current study is twofold: (i) a proposed scheme for buyer coalition formation services based on the assumption that individual buyer in the coalition have private preferences; and (ii) as a result of the above, various amounts of discounts and benefits can be calculated based on different methods of MCDM technique and the correlation between the different methods in MCDM technique with individual buyer preference ranking can be shown. These can help buyers consider private preference for forming a coalition. This in turn suggests that our proposed scheme can be incorporated in existing buyer coalition services as a complementary component. The article is organized as follows. We present background and related works. Then, we provide details of our proposed scheme. We further introduce the research methodology adopted in the present study and present the validation simulation of our approach. Finally, we discuss the conclusion and our future works.

## BACKGROUND AND RELATED WORKS

### N-Person Game Theories

We first introduce various significant concepts in n-person game theories in forming a coalition such as the core, the Shapley value, and the bargain set. The core (Gillies, 1959) of a coalition game is a set of imputations in which no subset of players has incentive to opt for an alternative coalition formation. Since the core gives a set of solutions, the Shapley value (Shapley, 1953) is proposed to give a unique solution. The payoffs of players depend on their contributions to a coalition. Since the solutions of these games (e.g., the core and the Shapley value) might be empty and to better describe a real outcome, the bargain set (Aumann, & Maschler, 1964) was developed to guarantee a solution. The bargain set is the set of the players’ payoffs such that no player has a justified (only) objection against any other players. However, these approaches are all based on assumption that the preference of each buyer is publicly known. While in many situations and applications, this assumption is unrealistic. Instead, buyers should be modeled as individuals with private preferences and decisions are made according to those preferences instead of shared knowledge. Therefore, some researchers (Chan & Leung, 2011; He & Ioerger,
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