Abstract

Solving real-world decision-making problems is a complex and uncertain process that involves carefully analyzing possible alternatives by Decision Makers (DMs). It warrants consideration of relative standings in terms of strength, weaknesses, acceptability, cost, consequences, etc., as factors for choosing one of the possible alternatives by the DMs. Thus, to ensure that the best possible solution is obtained, a DM individualistically requires careful analysis and consideration of all available information; it may not be possible to automate the same.

In the case of Group Decision Making (GDM), multiple individuals participate, and each member contributes their knowledge and expertise to achieve a collective decision. Compared with individual decision-making, the GDM ensures the participatory role of each and every DM having diverse perspectives, knowledge and expertise to be made use of. Therefore, the decision-making can be considered to be based on the collaborative approach to achieving consensus. In GDM, each participant may have some unique goal or motivation and their own approach for furnishing their preferences for the alternatives but have the common interest in obtaining the solution, which is agreed by most of them. For this purpose, the DMs provide preferences using a set of evaluations for the set of alternatives. The GDM then requires the aggregation of decision preferences expressed by the individuals, which is to be followed by exploiting the same to work out the possible rank assigned to the decision alternatives. Here, it has to be noted that the above exploitation process does not necessarily check any agreement on a single decision to be prescribed. Hence, it is likely that the solution will not be accepted by some of the participants (i.e., DMs) if they feel that their objectives have not been taken into consideration in solving the problem. Therefore, for the problems requiring cohesiveness

on the agreed solution, an additional phase in the decision process called as the Consensus phase is required. Such a phase incorporates a maximum degree of agreement among the DMs on their preferences before reaching a solution which will be called the consensual solution.

Obtaining a solution that is adhered to by most or all of the DMs is important. For that, Consensus Reaching Process (CRP) is deployed so as to achieve consensus on a decision that is preferred by most or all the DMs. To date, several models of CRP have been proposed, and from the literature of CRP, the assumptions made in the consensus-driven GDM process can be summarized in the following manner: all DMs are consensus-ready, all DMs are continuously available in all the iterations, the CRP may take the differing number of iterations in different scenarios of the GDM process, and lastly, there is a central node/authority that collects the preferences and provides feedback so as to enable the DM to incorporate changes in the preferences for the purpose arriving at a consensus. Taking into account these assumptions, this thesis considers a consensus-driven GDM scenario for working out the observations for the purpose of enrichment of GDM involving a CRP.

Through a detailed literature survey on CRPs in GDM problems, some major issues and challenges are identified in this thesis. After that a possible solution to those problems is proposed. While doing that, to simplify the survey process, we first divide the existing CRPs into four categories and find the research gaps. Lastly, four consensus-based GDM models are proposed, analyzed and characterized to overcome the identified research issues. The first two consensus models developed a focus on tapping the potential of non-expert DMs and facilitating experts in reaching a consensus at once. The third consensus model handles the scenario when some DMs may not be available at

times, and the last proposed model ascertains the trust and security in the decentralized decision-making structure supported by blockchain technology.

The GDM discussed so far considers that the DMs provide preferences based on their knowledge and beliefs, which is aggregated for providing feedback to each individual DM so as to enable them to incorporate changes in their preferences for all possible decision instances. This may be done in multiple rounds until they arrive at a consensus. Here, it should be noted that the thinking process of an individual DM for the purpose of giving the preference in the first round of iteration, considering feedback after every iteration, and incorporating modifications in the preference in the subsequent iterations, is all the human activities of DMs. Therefore, no algorithmic description of the same would be possible. Since the thought process of the mind of a DM has no algorithmic description (just as the halting problem studied in Algorithms in Computer Science doesn't have any algorithmic solution, and even infinite time would not suffice to solve that problem), working out the preferences regarding possible decision alternatives cannot be carried out by a machine. Moreover, for the purpose of application of GDM at the places such as the group recommender systems, it is obvious that such an approach is an attempt to replace the human mind activity in the algorithmic way wherein the automatic generation of preferences and modification of preferences takes place. Thus, we believe that the consensual opinion obtained with the involvement of human mind, as presented in this thesis, can provide a better decision aid that organizations or individuals use as a reference to achieve consensus in large-scale decision-making situations or emergency situations, or any realistic situations.