

Chapter 60

Group Decision Making for Advanced Manufacturing Technology Selection Using the Choquet Integral

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ABSTRACT

Advanced manufacturing technology (AMT) is defined as a modern method of production incorporating highly automated and sophisticated computerized design and operational systems. Hence, an investment decision to adopt AMT is a strategic decision. A group decision making process is stressful when group members have different views under multiple and conflicting criteria. Satisfying group members' opinions has a critical impact on a decision. In this chapter, a multiple criteria group decision making problem under a fuzzy environment is used for the selection among AMTs. Choquet integral methodology is used for this selection. A strategic investment problem of a company for a suitable Automated Storage/Retrieval System (AS/RS) is considered and discussed.

INTRODUCTION

The developments of science and technology have led to many new concepts and products, which are replacing the old ones. Flexibility, improvement in productivity and quality, faster response

to market shifts, shorter throughput and lead time and savings in inventory and labor costs, enable customer demands to be met in a shorter time. Changing customer preferences and tastes oblige the manufacturer to change his products frequently. Increased consumer awareness has led to the manufacture of high-quality goods.

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The manufacturing process has to be faster to meet market demands at the appropriate time and to overcome competition. All these factors have led to changes in manufacturing processes, which have prompted many manufacturers to adopt computer-integrated manufacturing, namely advanced manufacturing technology (Aravindan & Punniyamoorthy, 2002).

The term “advanced manufacturing technology” (AMT) is broadly defined to include any automated (usually computer oriented) technology used in design, manufacturing/service, and decision support. Components of AMT include computer-aided engineering, factory management and control systems, computer-integrated manufacturing processes, and information integration. Different researchers have defined AMT in various ways. Typical items constituting AMT include: robotics, automated guided vehicles (AGVs), computer numerically controlled machines (CNC) machines, flexible manufacturing systems (FMS), computer-aided design (CAD), computer-aided manufacturing (CAM), information technology, cellular manufacturing and the use of just-in-time (JIT)/kanban system in the plant (Das and Jayaram, 2003)

AMTs provide many important benefits such as greater manufacturing flexibility, reduced inventory, reduced floor space, faster response to shifts in market demand, lower lead times, and a longer useful life of equipment over successive generations of products. Like many real-world problems, the decision of investing in advanced manufacturing technology frequently involves multiple and conflicting objectives, such as minimizing costs, maximizing flexibility, minimizing machine down times and maximizing efficiency. Application of traditional capital budgeting methods does not fully account for the benefits arising from intangible factors of AMTs (Kahraman et al., 2000).

The rapid growth of the AMT industry is creating problems in new directions. Prospective firms face the situation of having to make a decision among several AMTs, all of which are

capable of performing a specific task. Since the development and use of appropriate assessment approaches are crucial to ensuring that the analysis of each AMT project considers all benefits and costs, the selection of a suitable AMT is becoming a more and more complex problem. Therefore the evaluation of the AMT is a multiple criteria problem and group decision making is generally preferred to solve these kinds of problem (Chuu, 2009). Group decision making requires considering multiple perspectives obtained from a group consisting multiple members (Lu et al., 2007). A group decision is required in two situations: (1) when a problem becomes too complex such that the knowledge of a decision maker is inadequate, as in product design, investment decisions and supplier selection and (2) when there are conflicting ideas that influence the decision makers like presidential elections. While the first one is called cooperative group decision making, the second one is called non-cooperative decision making. The common features of both decision making problems is to satisfy multiple decision makers' preferences. Therefore, there are several kinds of group decision making methods in the literature such as authority rule, majority rule, negative minority rule, ranking rule, and consensus rule.

In this chapter, a multiple criteria group decision making problem under fuzzy environment is discussed to select an appropriate AMT by using the Choquet integral since the problem is related to both subjective and objective criteria. For a long time, it has been recognized that an exact description of many real-life physical situations may be virtually impossible. This is due to the high degree of imprecision involved in real-world situations.

Zadeh (1965, 1968) in his seminal papers proposed fuzzy set theory as the means for quantifying the inherent fuzziness that is present in ill-posed problems. Fuzziness is a type of imprecision which may be associated with the sets in which there is no sharp transition from membership to nonmembership. Many problems

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