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Development of a justification tool for advanced manufacturing technologies: system-wide benefits value analysis

Sharon M. Ordoobadi*, Nancy J. Mulvaney

IMSE Department, College of Engineering, 237 Durland Hall, Kansas State University, Manhattan, KS 66506, USA

Abstract

Growing competition and increasing demands from customers are forcing small manufacturers to consider investments in advanced manufacturing technologies (AMTs). For many reasons, such investments are often difficult to justify by means of a traditional economic analysis alone. As a result, it is often necessary to consider the system wide benefits associated with AMTs in order to justify their adoption. A process known as system wide benefits value analysis (SWBVA) has been developed to assist decision makers with their advanced technology decisions. Users of the tool first perform an economic analysis to see if the investment is economically justified. If it is not yet justified, the gap between the minimum desired economic return and the actual return amount is calculated. Users can follow a series of procedures to determine if the value of the system wide benefits associated with the advanced technology is sufficient enough to justify this gap. These procedures involve customizing a formal model of system wide benefits to suit the technology decision being evaluated, setting desired goals for each benefit being considered, and answering a series of input questions about the level of those benefits they feel can be obtained from such a technology. A fuzzy expert system is the internal mechanism used to manipulate user inputs into crisp output values for each benefit category. If the determined output values for each system wide benefit are greater than or equal to the user-defined benefit goals, then the gap amount is believed to be justified. Users are provided with a summary report on the calculated results and are allowed to readjust their benefit goals and repeat the analysis if necessary.

Keywords: Advanced manufacturing technology; System-wide benefits; Justification tool; Fuzzy expert system

* Corresponding author. Tel.: +1-785-532-5606; fax: +1-785-532-7810.
E-mail address: share@ksu.edu (S.M. Ordoobadi).

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1. Introduction

Innovation and the adoption of advanced technologies are crucial activities for manufacturing firms today. This is especially true for smaller manufacturing firms which have not necessarily established formal processes for research and development (R&D). R&D challenges facing small manufacturers are numerous (Wallsten, 1998). Small manufacturers often take on an antiquated philosophy when it comes to innovation, and although there seems to be no scarcity of good ideas within these companies, the ability to take ideas and develop them into new products or processes is often lacking. The evaluation tool proposed here is but one aspect of a larger project that is underway on the management of technological innovations (MOTI) for small manufacturers.

The main purpose of this paper is to identify and analyze the technological, psychological, and behavioral barriers that inhibit the innovation process in smaller firms, and to likewise uncover the success factors that make prosperous innovations possible. Through preliminary interviews with small manufacturers in Kansas, it was determined that this objective could best be met through a tool that provided examples of past successes and failures in the innovation process, while serving as a useful guideline for gaining insight and making decisions about current innovative ideas. This main aspect of the project is partially fulfilled through the collection and organization of a database of cases that describe examples of past manufacturing innovation successes and failures. The case database has been developed through a series of interviews and focus group discussions with chief executive officers (CEOs), presidents, and managers of small manufacturing firms in Kansas. Two tools are being developed simultaneously to utilize the case database and fulfill the main objectives of the project: (1) a tool which utilizes case grammar to classify past cases and draw comparisons to current situations and (2) a tool which applies analogical reasoning and proverbs to describe past cases and make comparisons to current scenarios (Xue, 1999).

The evaluation tool presented here is meant to be a supplementary tool to this larger aspect of the project. It is felt that once firms have the opportunity to analyze their current ideas through the examination of cases in the aforementioned tools, a mechanism for formally evaluating those projects then becomes necessary. The methodology presented here will enable decision makers in small manufacturing firms to make informed and complete analyses of their potential advanced technology projects. Such analyses will consider not only the traditional cost factors involved in such investments, but also the secondary, system wide benefits that can often be obtained with advanced technologies.

The following sections will describe the proposed tool, system wide benefits value analysis (SWBVA), in further detail. First, a comprehensive outline of the problems associated with evaluating advanced technologies along with an analysis of the literature on past evaluation methods is presented. The next section includes an introduction to the SWBVA along with a depiction of the benefits model and a description of the SWBVA process. A synopsis of the data collection modes for the modeling aspects of the system is provided next, followed by an account of the modeling procedures themselves. Finally, an example to illustrate application of the tool is offered along with some conclusions and suggestions for future research.