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Model based interpretation of survey data: A case study of enterprise resource planning implementations

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Abstract

The selection of the appropriate analysis tools for survey data is an important decision for all researchers dealing with responses on questionnaires. Over the last two decades a number of approaches have been used for classifying variables, statistically measuring significance and developing predictions of outcomes. This paper compares and evaluates the use of regression analysis, logistic (logit) models, discriminate analysis and data envelopment analysis (DEA), for empirical data from a survey of enterprise resource planning (ERP) implementations in the US manufacturing sector. The data collected from this survey contains a mix of subjective and objective data, and provides an opportunity to assess the impact of these modeling techniques on measuring outcomes and a decision-maker's acceptability of the results. The analysis illustrates that regression based tools are more valuable in developing predictive models, while logit and discriminate models are powerful in classifying the outcomes. The genetic search-based discriminate model is intuitively appealing, whereas DEA provides additional information with respect to understanding the process of arriving at the outcome over other tools. The analysis further shows that these techniques can be used in a complementary manner to insights that they cannot provide when used individually. In addition to the feasibility of these techniques, this analysis also provides important insights into ERP implementations.

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1. Introduction

Various mathematical and statistical methods have been used to analyze empirical data to verify hypotheses, calculate variances, and identify critical factors contributing to outcomes of interest. One of the most commonly used techniques is regression analysis. Using regression to evaluate empirical data has a very rich and well-documented history [1]. This observation is not surprising, since regression is one of the most robust statistical tools available to a researcher. It can be used to identify and measure underlying factors influencing the outcomes of interest, as well as

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to develop predictive models using these factors. However, other mathematical techniques have been proposed during the last two decades as alternatives for analyzing and classifying empirical data. These include logistic (logit) analysis, discriminate analysis, and data envelopment analysis (DEA).

Logit models are a subset of the robust regression approach. In this case the outcomes are in a binary format for independent variables that can be either objectively or subjectively based. Like a logit model, discriminate analysis is also used to classify data based on pre-defined inputs. Within discriminate analysis, linear discriminate methods are particularly popular, mainly because of the ease of using them and interpreting the results [2]. Discriminate analysis is generally performed using statistical estimating procedures, but techniques such as linear programming, integer programming, and genetic search have been employed to further refine the process and the results. While logit analysis and discriminate models are useful in classifying outcomes, DEA is an objective method for determining and benchmarking operational efficiency [3]. Efficiency is measured relatively as the maximum value of a fractional linear objective function of the weighted sum of the outputs divided by the weighted sum of the inputs. The inputs and outputs are pre-specified by the investigator(s). Typically, discriminate analysis and DEA are used to model objective data such as test scores, sales data, market shares, and loan amounts, and limited applications with subjective data.

All four of these techniques have different strengths in providing insights into empirical data either in terms of classification, measurement of relevance, or prediction of outcomes. For example, regression can be used to predict outcomes as well as significance of variables. Similarly, DEA can be used to explain efficiencies in terms of input resources used and derived outcomes, instead of just a classification of outcomes into a binary set, but DEA has no tests for significance. Both DEA and discriminate analysis allows the decision-makers to use their experience-based intuition by pre-specifying key variables for the analysis, making it more likely for them to accept the analyzed outcomes. Logit models, on the other hand, use regression techniques to arrive at classifications.

In this paper, we analyze and compare the feasibility of using regression analysis, logit models, discriminate analysis and DEA for empirical data from a survey of enterprise resource planning (ERP) implementations in the US manufacturing sector. The data collected contains a mix of subjective and objective data, and provides an ideal opportunity to determine the strengths and weaknesses of applying these models to survey data that is primarily subjective. The analysis also assesses the impact of these modeling techniques on outcomes and a decision-maker's acceptability of the results. In addition to the feasibility of these techniques, this analysis also provides important insights into ERP implementations and practice.

The rest of the paper is organized as follows. The next section provides the details of the data and the data collection methodology. [Section 3](#) provides an overview of the modeling techniques evaluated and the results. [Section 3.1](#) discusses the insights and interpretations that decision-makers will obtain using these four approaches. The conclusions are presented in [Section 3.2](#), with a summary table highlighting and ranking the important dimensions of the four analysis techniques evaluated.

2. Case studies and data collection

The data for this analysis comes from a survey of US manufacturing companies on their ERP implementations. This survey has been conducted as part of a long-term on-going project aimed at studying ERP practice in the manufacturing sector. ERP systems, which have evolved from materials requirements planning (MRP) and manufacturing resource planning (MRP II) systems, are designed to integrate and optimize various business processes like financial accounting, order entry, sales and distribution, human resources, materials management and production planning across the entire enterprise. According to industry reports, at least 30,000 companies worldwide have implemented ERP systems.

Almost all ERP implementations have taken place in the mid-to-late 1990s. Thus, these systems are relatively new, with very little research available concerning their implementations, operations or impact [4]. Much of the initial literature in ERP consists of articles or case studies either in the business press or in practitioner journals. These publications have chronicled both some high profile failures and difficulties [5–7], and also some model implementations [8]. More recently, several academic papers have dealt with various aspects of ERP. Davenport [9] looks at the reasons for implementing ERP systems and the challenges of the implementation project itself. McAfee [10] and Stratman and Roth [11] both look at operational performance. Van Everdigen et al. [12] and Mabert et al. [4] both use surveys to study a variety of issues systematically.

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